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Black Sea assessments (STECF-14-14)

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Black Sea assessments (STECF-14-14)

THIS REPORT WAS REVIEWED BY THE STECF BY WRITTEN PROCEDURE DURING OCTOBER 2014

1.1. Request to the STECF

STECF is requested to review the report of the STECF Expert Working Group meeting 14-14, evaluate the findings and make any appropriate comments and recommendations.

1.2 Observations of the STECF

The EWG 14-14 attempted to develop quantitative stock assessments for nine species. Seven of the assessments (for sprat, turbot, whiting, Mediterranean horse mackerel, Black Sea anchovy, piked dogfish, and red mullet) are considered to be of sufficient quality to provide analytical estimates of recent exploitation rates and stock status in relation to proposed biological reference points. However, it was not possible to provide short-term catch forecasts for whiting, horse mackerel, anchovy and piked dogfish. Exploration of the available data to determine the current stock status of Atlantic bonito and rapa whelk proved to be inconclusive.

1.3 Conclusions of the STECF

STECF endorses the findings presented in the report of the EWG 14-14 and draws the following conclusions.

Management reference points

STECF concludes that the following limit reference points, which are consistent with high long-term yields are appropriate proxies for F_{MSY}.

- Sprat: $F_{MSY} = F \leq 0.64$, consistent with the exploitation rate $E \leq 0.4$.
- Turbot: $F_{MSY} = F \leq 0.26$, the median F for MSY based on simulations that included model uncertainty in the stock-recruit relationship
- Whiting: $F_{MSY} = F \leq 0.40$, consistent with $F_{0.1}$
- Mediterranean horse mackerel $E_{MSY} = E \leq 0.40$
- Black Sea anchovy $F_{MSY} = F \leq 0.56$, consistent with the exploitation rate $E \leq 0.4$.
- Piked dogfish: $F_{MSY} = F \leq 0.03$, by analogy with North East Atlantic spurdog.
- Red mullet: $F_{MSY} = F \leq 0.46$, consistent with $F_{0.1}$

Proposed limit and precautionary management biomass reference points proposed are:

Turbot: B_{lim} = 3,535 t: B_{pa}= 4,949 t.

Stock status

STECF concludes that in relation to the above reference points, the current status of these species in the Black Sea is summarized as follows.

- <u>Sprat</u>: Fishing mortality in 2013 is estimated to be F = 0.446, which is less than F_{MSY} (F = 0.64) and lower than the peak F value estimated for 2011 (F = 1.2) when the stock was subject to overfishing.
- <u>Turbot</u>: Fishing mortality in 2013 is estimated to be F = 1.33, which is more than five times the F_{MSY} (F = 0.26). The stock has been exploited at rates exceeding F_{MSY} for many years and is severely depleted. SSB in 2013 (1,634 t) is estimated to be less than half of B_{lim} (3,535 t).
- <u>Whiting</u>: The fishing mortality in 2013 is estimated to be F = 1.15, which is almost three times the F_{MSY} (F = 0.4). The stock has been exploited at rates exceeding F_{MSY} for several years.

- Mediterranean horse mackerel: Fishing mortality in 2013 is estimated to be F = 1.42, corresponding to an exploitation rate of E = 0.78, which is almost twice the F_{MSY} exploitation rate of E = 0.4. The stock has been exploited at rates exceeding F_{MSY} for several years.
- Black Sea anchovy: Fishing mortality in 2013 is estimated to be F = 1.2, which is almost twice F_{MSY} (F_{MSY} = 0.56). The stock has been exploited at rates exceeding F_{MSY} for many years even though, fishing mortality has been declining in recent years.
- Dogfish: The fishing mortality rate during 2013 is estimated to be F = 0.112, which is more than 3.5 times the F_{MSY} exploitation rate of F = 0.03. Recent catches of this long-lived and relatively unproductive species are very low compared to the past and the stock appears to be severely depleted.
- Red mullet: The fishing mortality rate during 2013 is estimated to be F = 1.17, which is more than 2.5 times the F_{MSY} exploitation rate of F = 0.46. The stock has been exploited at rates exceeding F_{MSY} for several years.

Fishing opportunities for 2015

In keeping with the CFP objective of achieving F_{MSY} in 2015, STECF advises that total international catches from the Black Sea (GSA 29) in 2015 should not exceed the following limits:

- Sprat: 48,775 t.
- Red mullet: 331 t.

In order to maximise the potential for recovery of the depleted stocks of turbot and piked dogfish in the Black Sea, STECF concludes that fisheries directed to these species should not be permitted in 2015. Hence, STECF advises that TACs for turbot and piked dogfish should be set as follows:

- Turbot: 0 t.
- Piked Dogfish: 0 t.

Because there is no international agreement on the allocation of fishing opportunities for Black Sea stocks, STECF is unable to advise appropriate EU quotas for sprat and red mullet.
Catch forecasts for 2015 for whiting, Mediterranean horse mackerel and Black Sea anchovy were not sufficiently reliable to be used as a basis for advice on fishing opportunities for 2015.

STECF notes that because rapa whelk is an invasive species in the Black Sea and has contributed to the decline of several native stocks of shellfish, STECF considers that it is not appropriate to constrain fishing activities to achieve MSY for rapa whelk. Fishing (using legally allowed gears) for rapa whelk and other actions that will restrict further growth of this stock should be encouraged, even if this means reducing the stock below the level consistent with MSY.

Proposals to enhance knowledge of Black Sea stocks and fisheries

- STECF considers that demersal and hydroacoustic surveys should be expanded so as to cover a greater proportion of the Black Sea, and they should be conducted annually. In addition, improved coordination of the existing national surveys should be considered.
- STECF considers that there should be a review of the fishery sampling programs of the Black Sea nations. This should document how the fishery and stock assessment data in the Black Sea are collected and to identify the causes of the data gaps that were apparent in the information provided to EWG 14-14.
- STECF considers that mechanisms should be established for all Black Sea stocks to ensure that age-reading specialists in the different national laboratories all use the same agreed protocols for

determining the age-readings. Procedures should be developed to assure that the age-readings are maintained to an acceptable quality standard.

- STECF considers that studies should be conducted to compile and review available information for all Black Sea stocks that would provide a scientific basis for the stock structure.
- STECF considers that there should be increased at-sea sampling of the sprat fishery to document discards of whiting and other bycatch species.
- STECF considers that members of the Black Sea EWG should participate in the GFCM workshop that will prepare to implement a fishery management plan for turbot in the Black Sea.
- STECF recommends that prior to the 2015 Black Sea EWG assessment meeting a workshop should be held to develop agreed and documented procedures for compiling the stock assessment data, developing the catch-at-age matrices, and extending the catch-at-age matrices to include earlier years.

During 2014 there was very little progress made to address the recommendations made in the 2013 report. The first six items in the above list were recommended in the 2013 report; the last two items are new.

Report to the STECF

EXPERT WORKING GROUP ON
Black Sea assessments
(EWG-14-14)

Barza d'Ispra, Italy, 6-10 October 2014

1. Executive summary

In response to the ToR the STECF EWG 14-14 on Black Sea stock assessments has endeavoured to develop stock assessments for nine stocks: sprat, turbot, whiting, Mediterranean horse mackerel, Black Sea anchovy, piked dogfish, red mullet, Atlantic bonito and rapa whelk. Relevant data were compiled and reviewed, including those called officially by DG Mare through the 2014 DCF data call for the Mediterranean and Black Sea. Expert knowledge completed the data, which were analyzed using a variety of stock assessment approaches. The data and methods applied to the nine stocks are documented in section 6 of the present report.

Among the nine stocks that were considered, assessments for seven of the stocks (sprat, turbot, whiting, dogfish and red mullet) resulted in analytical estimates of exploitation during 2013 relative to estimated FMSY reference points, consistent with high long term yields and low risk of stock collapse. The assessment results for whiting, horse mackerel, anchovy, and dogfish are not sufficiently reliable to be used as a basis for short-term catch forecasts. The assessments for Atlantic bonito and rapa whelk, which were explorations of the available data, were inconclusive with respect to stock status.

STECF EWG 14-14 reviewed gaps in current knowledge and data, evaluated the progress made in addressing such gaps since last year, and formulated recommendations for addressing such gaps in the future. Some of the gaps that were identified were: limited survey coverage to provide tuning indices for the assessments; inadequate sampling of the landings for information on age composition and at sea for information on discards; and uncertainty whether there are multiple stocks of a given species within the Black Sea, and the boundaries that would separate these stocks.

In addition to the section with detailed assessments for each of the nine stocks, the present report provides a section with an overall summary of the EWG's findings and conclusions, a section with follow-up items that may improve the process for producing the next set of Black Sea stock assessments, and a section with a short summary sheet for each of the nine stocks that describe the stock and the status of its fisheries, and catch projections as appropriate.

Synoptic table of the stock assessed during EWG 14-14. In red are stocks for which current F is larger than FMSY.

Stock area	Common name	Species	Assessment	Status	F/F_{MSY}	F	F_{MSY}	Short term	Medium term
GSA 29	Sprat	Sprattus sprattus	ICA	sustainable	0.70	0.45	0.64	yes	
GSA 29	Turbot	Psetta maxima	XSA	overexploited	5.12	1.33	0.26	Yes	No
GSA 29	Whiting	Merlangius merlangus	yes, trends only	overexploited	2.89	1.15	0.40	no	No
GSA 29	Mediterranean horse mackerel	Trachurus mediterraneus	Yes	overexploited	1.95	0.78	0.40	no	No
GSA 29	Anchovy	Engraulis encrasicolus	Yes	overexploited	1.40	0.56	0.40	no	No
GSA 29	Piked dogfish	Squalus acanthias	yes	unknown	9.00	0.27	0.03	no	No
GSA 29	Red Mullet	Mullus barbatus	Yes	unknown	2.53	1.17	0.46	yes	No
GSA 29	Atlantic bonito	Sarda sarda	Exploratory	unknown				no	No
GSA 29	Rapa whelk	Rapana venosa	No	unknown				no	No

2. Findings And Conclusions Of The Working Group

The Working Group had little time during the meeting in Barza for detailed discussions of the data or the assessment results, because most of meeting time was needed for assembling and analysing the information provided for the nine stocks that the Group considered. However, some issues were debated and noted by the Chair. After the meeting the Working Group conferred by email correspondence and agreed to the following items, which are organized in terms of findings and resulting conclusions.

General Findings & Conclusions that Apply to More than One Stock

Finding: Uncertainty regarding stock boundaries.

As was the case in 2013, the stock assessments conducted by the Working Group in 2014 generally treated all the fish of a given species as being part of a single Black Sea stock. However, the Working Group was not provided with evidence to either support or refute the assumption that all the sprat (for example) caught in the Black Sea are from a single stock. Some national experts expressed the opinion that the fish occurring within their national waters were a unique stock, implying that these fish did not intermingle with the fish in the waters adjacent to their nation. While it is implausible that fish respect national boundaries, it is also true that there is little conclusive evidence to support the assumption that the Black Sea only supports single stocks of all the species that the Working Group considered.

> Conclusion: As was the case in 2013, additional work is needed to compile and review available information that would provide a scientific basis for the stock structure of the fish stocks in the Black Sea. Results from genetic studies would provide the most definitive proof, but other types of analyses might also provide an adequate basis for determining whether there are multiple stocks of turbot (for example) in the Black Sea. Given the complexity of the issues, it will not be feasible to resolve stock identification and boundary issues during a meeting that is also responsible for developing stock assessments.

Finding: Poor coverage by surveys.

Many of the stock assessments were limited by a general lack of tuning indices. This was a significant problem for the pelagic species in particular. In 2008 it was agreed that Bulgaria and Romania each year would jointly implement two bottom trawl surveys and two acoustic surveys in the EU waters of the Black Sea. The surveys were conducted by both nations in 2011 and 2012, but a bottom trawl survey was conducted only in Romanian waters in 2013. No hydroacoustic surveys were conducted in EU waters of the Black Sea in 2013. A demersal survey of Romanian waters was completed during May 2014. Bottom trawl and acoustic surveys in Bulgarian and Romanian waters are pending during autumn 2014.

> Conclusion: The issues that have prevented the bottom trawl and acoustic surveys from being conducted need to be resolved so that these important sources of fisheries independent data will available on a consistent and routine basis.

Finding: Uneven sampling for age-at-length or age-composition.

Catch-at-age matrices are fundamental information for the stock assessments. To construct the catch-at-age matrices, the assessment coordinators often had to borrow age-length keys from other nations or from surveys because the sampling of the landed catch was erratic or completely missing.

Age-length keys reflect the characteristics of the fishing gear that caught the fish and also the traits of the fish population that was being fished. The age-length keys will provide a poor reflection if applied to fish caught with a different gear or from a different segment of the population. As a general rule, the practice of borrowing age-length keys should be avoided because it can result in biased estimates of catch-at-age.

> Conclusion: A review of the national fishery sampling programs is needed to document how the fishery information is being collected and to identify the causes of the data gaps that were apparent in the information provided to the Working Group.

Finding: Inconsistent methods for estimating catch-at-age between national laboratories.

The methods used for estimating catch-at-age were unclear for many stocks and the methods may be inconsistent between the national laboratories. This situation could lead to biased estimates of catch-at-age when data from different nations are combined, especially given that assessment coordinators sometimes have to borrow age-length keys from other nations. Incorrect assumptions regarding how sample data were collected could result in the data being treated incorrectly.

Finding: Short catch-at-age data series for some stocks.

The assessments for horse mackerel and whiting had very short time series of catch-at-age data, which greatly limited the EWG's ability to explore the assessments' diagnostics and interpret the stocks' dynamics.

> Conclusion: A workshop is needed in advance of the next Black Sea EWG meeting to develop acceptable and agreed methods for constructing and compiling catch-at-age matrices for use in the EWG assessment meeting. The workshop should identify gaps in essential information (e.g., no age-length keys for segments of the fisheries) and recommend procedures for imputing reasonable estimates for those data gaps and for extending the catch-at-age matrices to include earlier years.

Finding: Age-readings may be inconsistent between national laboratories.

For some stocks there is circumstantial evidence that the age-reading techniques differ between the national laboratories (e.g., discrepancies were apparent in mean length-at-age).

> Conclusion: A mechanism is needed to ensure that age-reading specialists in the different national laboratories all use the same agreed protocols for determining the age-readings. Procedures are needed for assuring that the age-readings are maintained to an acceptable quality standard.

Finding: Ukraine fisheries data for Crimea.

Official Ukraine data from Crimea will be unavailable for 2014 and probably in the future as well.

> Conclusion: Interpretation and analysis of data series will be more difficult and uncertain in future assessments due to the break in the time series for Ukraine and the Russian Federation.

Stock-Specific Findings & Conclusions

Sprat

Finding: Sprat is a relatively short-lived pelagic species and catches are predominately age-1 and age-2 fish. Fish that are 4 years or older are rarely caught. Discards of sprat are evidently very low. Most of the reported landings of sprat since 2004 were taken by Turkey (47%).

Finding: For the period 1993 to 2012 catches of sprat in the Black Sea increased steadily from a low level of about 17 thousand tons in 1993 to a first peak level of about 72 thousand tons in 2002, and a subsequent peak of almost 121 thousand tons in 2011. Catch during 2013 was only 27 thousand tons.

Finding: The Integrated Catch Analysis (ICA) method was applied to catch-at-age data assembled for the entire Black Sea for the period 1993 to 2013.

> Conclusion: The EWG endorses the stock assessment for sprat and considers that the stock was exploited unsustainably during 2010, 2011 and 2012 (but not during 2013). The catch forecast for 2014 based on the accepted proxy for F_{MSY} (exploitation ≤ 40%) is 48 775 t, which is more than the catch forecast under status quo fishing.

Finding: There is concern that the fishery for sprat produces significant quantities of bycatch and discard of other fish species, such as whiting.

> Conclusion: There should be increased sampling of the sprat fishery by at-sea observers to quantify the amount of bycatch and discarding.

Turbot

Finding: Turbot is a relatively long-lived demersal species and catches are predominately age-4 to age-6 fish. Discards of turbot in the directed fisheries are considered to be negligible. Most of the reported landings of turbot since 2004 were taken by Turkey (56%).

Finding: For the period 1950 to 2012 the annual catches of turbot dropped from an average of about 4000 t during the 1950s and 1960s to an average of about 2000 t during the 1990s and 2000s. Except for a slight increase in catch in 2012, the annual catches have declined steadily since 2007.

Finding: After 2001 annual landings of turbot by Turkish vessels operating in the western portion of the Black Sea dropped abruptly by about 1200 t. These Turkish vessels had been operating in waters off Bulgaria, Romania and western Ukraine, but increased control measures forced them to stop. To derive estimates of IUU catch of turbot during 2002 and subsequent years, it was assumed that the same level of fishing for turbot continued after 2001 as had occurred prior to 2001, but was conducted by local fishers and was unreported.

Finding: The State-space Assessment Model (SAM) approach was applied to catch-at-age data for age-classes 2 to 10+ from the period 1950 to 2013. The estimated F for 2013 (1.33) exceeds the previous historical high level (in 2001) and is more than five times the estimated F_{MSY} (0.26). The assessment indicates that the spawning stock biomass continues to be at very low levels (around 1634 t) and it is estimated to be less than half of B_{lim} (3535 t).

> Conclusion: The EWG endorses the stock assessment for turbot in the Black Sea and considers that the stock has been exploited unsustainably in recent years and remains at risk of collapse. Fishing mortality remains at high levels and has been increasing with no sign of reduction, despite the recently low TACs.

Finding: The stock assessment assumed that all turbot in the Black Sea are part of a single stock. The Group was not provided with strong evidence either that there are multiple stocks of turbot in the Black Sea or that there is a single stock.

Finding: The assessment estimates that turbot SSB reached its peak in 1979 and then declined dramatically during the 1980s to half as large as it was during the 1950s and 60s. During the most recent seven years SSB has declined steadily and reached its historic low in 2013. It is unlikely that these changes in biomass occurred uniformly in all regions of the Black Sea.

Conclusion: Given that the overall spawning biomass of turbot in the Black Sea is likely to be at very low levels (regardless of whether there are multiple stocks, or only one stock), it would be prudent to adopt a precautionary approach for managing Black Sea turbot, until such time that it can be established that there is more than one turbot stock and that the healthier stock(s) can be managed independently and without detriment to the weaker one(s).

Whiting

Finding: Whiting is a relatively short-lived demersal species and landings are predominately age-2 to age-3 fish, but large numbers of age-0 and age-1 fish are caught and discarded by non-target fisheries. Targeted fishing for whiting is done almost exclusively by Turkey. Most of the reported landings of whiting since 2004 were taken by Turkey (98%).

Finding: Discarding of whiting, particularly of young fish (age-0 and age-1), appears to be a large but variable fraction of the annual catch of whiting in many of the national fisheries (other than those of Turkey), but the available sample data are patchy and there are major gaps in the sample record.

Conclusion: It was not possible to develop scientifically defensible estimates of the annual catches of age-0 and age-1 whiting in the Black Sea.

Finding: For the period 1994 to 2013 annual estimated catches of age-2 to age-6+ fish fluctuated around 7 000 t with a low of 2 159 t in 2005 and a peak of almost 17 000 t in 2010 and then declined. Catch during 2013 was slightly less than 8 200 t.

Finding: The XSA method was applied to whiting catch-at-age information from 1994 to 2013 for age-classes 2 to 6+. During this period the SSB varied without any clear trend, but the estimate for 2013 was the lowest of the series. The estimates of age-2 recruitment in this assessment do not account for the large but variable rates of fishing mortality experienced by each cohort during their first two years of life.

Conclusion: The EWG does not consider that the stock assessment for whiting in the Black Sea provides quantitative estimates of stock biomass or rates of fishing mortality that are valid for all age classes, but the Group does consider that the assessment results are valid indicators of trends in spawning biomass.

Finding: The assessment estimated that the fishing rate F(2-4) during 2013 was = 1.154, which greatly exceeds the F_{MSY} proxy, $F_{MSY}(1\text{-}4) \leq 0.4$, proposed by EWG 14-14 as the limit reference point consistent with high long term yields and low risk of stock collapse.

Conclusion: The EWG 14-14 classifies the stock of whiting in the Black Sea as being potentially exploited unsustainably.

Mediterranean Horse Mackerel

Finding: The Mediterranean horse mackerel is a moderately short-lived pelagic species and landings are predominately age-1 and age-2 fish, but appreciable numbers of age-6+ fish are sometimes caught. No discards of horse mackerel have been reported. Most of the reported landings of horse mackerel since 2004 were taken by Turkey (96%).

Finding: During the period assessed (2004 to 2013) annual catches of horse mackerel increased markedly from just under one thousand t to a peak of almost 25 thousand t in 2012, but historically the reported landings of horse mackerel have been as high as 141 thousand t (in 1985).

Finding: A stock assessment was conducted using XSA applied to catch-at-age data for age-classes 0 to 5+ for the period 2004 to 2013, and a tuning index based on commercial CPUE data from a Turkish purse-seine fleet. The estimated F for 2013 was 1.42, corresponding to an exploitation rate of 0.78, which is almost double the 0.4 exploitation rate that is considered to be consistent with long term exploitation of a pelagic stock.

Conclusion: The EWG endorses the results of the XSA analysis of horse mackerel and considers that the stock has been exploited unsustainably in recent years.

Finding: The tuning index for the assessment was an aggregated CPUE index that was split to age-classes using the age structure of the catch matrix from Turkey. While this index was an improvement over the tuning index available for the 2013 assessment, the EWG considered that the index was crude and potentially unreliable.

Conclusion: An international hydro-acoustic survey is needed to monitor trends in the horse mackerel age-structure and stock biomass across all national waters of the Black Sea.

Anchovy

Finding: Black Sea anchovy is a short-lived pelagic species and catches are predominately age-0 to age-3 fish. Most of the reported landings of anchovy since 2004 were taken by Turkey (85%). The EWG did not consider the status of the Azov Sea anchovy, which is considered to be a separate stock from the Black Sea anchovy and is harvested almost exclusively by the Russian Federation.

Finding: Possible mixing on the fishing grounds of Black Sea anchovy with Azov Sea anchovy remains an important source of uncertainty for the stock assessment and management of Black Sea anchovy.

Finding: During 1988 to 2012 the annual catches of Black Sea anchovy varied from a low of 71 thousand t to 378 thousand, with no particular trend except for a 6-year period of steady increase during 1990 to 1995. The landings during 2013 were 2266 thousand t and higher than in 2011 and 2012, but historically the reported annual landings of Black Sea anchovy have been as high as 392.6 thousand t (in 1988).

Finding: The XSA stock assessment method was applied to Black Sea anchovy catch-at-age data for age-classes 0 to 4+ from the period 1988 to 2012. CPUE data from the Turkish purse seine fleet were used as the primary tuning index. The ASPIC surplus production method was applied to catch and effort data for the period 1970 to 2013, with fishing effort measured in terms of the number of purse seiners. Both the XSA and the ASPIC assessments assume that the CPUE series provide valid indices of stock biomass and that fishing power has not changed over time.

Finding: The XSA and ASPIC assessment results differed in their interpretation of trends in biomass during the 1990s but gave similar estimates of trends in biomass and fishing mortality in recent years. The XSA estimates of F for 2013 was 1.2, corresponding to an exploitation rate of 0.59, which is higher than the precautionary threshold of 0.4 exploitation recommended for small pelagic fish.

Conclusion: The EWG endorses the results of the XSA assessment for Black Sea anchovy and considers that the stock was exploited unsustainably in recent years, but notes that the rate of fishing mortality has declined relative to 2010 and 2011.

Finding: The acoustic survey data, which are crucially important for the reliability of assessment results for a short-lived, schooling pelagic species such as anchovy, are limited to the most recent three years, supplemented with older data from Ukrainian and former U.S.S.R. hydroacoustic surveys.

Conclusion: Turkey should be strongly encouraged to continue its program of conducting acoustic surveys of the Black Sea anchovy stock.

Piked Dogfish

Finding: Piked dogfish is a pelagic species that is long-lived, late maturing, and has low fecundity, which means that the stock probably has very limited capability to rebound quickly once it becomes depleted. Significant quantities of dogfish probably are caught in trawl and purse-seine fisheries and then discarded, but the magnitude remains largely unquantified and the biological characteristics (e.g., sex and length composition) of the discarded animals are unknown. Most of the reported landings of dogfish since 2004 were taken by Turkey (45%).

Finding: The reported landings of piked dogfish have dropped steadily and dramatically since the start of the landings series, from more than 6 000 t in 1989 to only 83 t in 2013.

Finding: The VIT program was applied to catch-at-age matrices for 1989-2013 that were derived from length compositions and age/length keys from Romanian samples and the assumptions M = 0.15 and terminal F = 0.15. The program YPR-LEN, which is based on methods that assume equilibrium conditions, including the assumption of constant recruitment, was used for obtaining reference points. The fishing mortality rate during 2013 was estimated to be 0.112, below the estimated $F_{0.1}$ = 0.204 proxy for F_{MSY}.

> Conclusion: Because results from the VIT analyses depend heavily on assumptions of unknown validity, the EWG views the results as being uncertain but indicative of the status of piked dogfish. The EWG cannot estimate a TAC constraint for 2015, but considers the stock to be overexploited.
>
> Conclusion: To inform any management actions that may be taken to recover the Black Sea stock of dogfish, it is important to document all sources of fishing mortality for dogfish, including discards by fisheries that do not target dogfish.

Finding: An exploratory XSA assessment was conducted, with tuning provided by the Romanian scientific demersal surveys conducted during 2011 to 2013. The results indicated a steady and major reduction in the spawning stock biomass since 1989. The estimates of current rates of fishing mortality are high (~0.3) and estimates of F for past years were erratic, exceeding 0.7 four times during 1999 to 2009.

Finding: ICES estimates that F_{MSY} for piked dogfish in the North East Atlantic is equal to 0.029, expressed as the proportion of the total catches over the total biomass, which corresponds approximately to an F=0.03.

> Conclusion: Given (a) the uncertainty in the VIT and YPR-LEN analyses, linked to the assumption of constant recruitment, (b) the preliminary nature of the XSA analysis, and (c) the absence of more reliable information, the EWG considers it precautionary to use the F_{MSY} value estimated by ICES for piked dogfish in the North East Atlantic as an appropriate proxy for F_{MSY} for piked dogfish in the Black Sea.

Finding: The age-composition data that underlie both the VIT and XSA assessments are derived from length compositions and age/length keys from Romanian samples, but Romanian landings of dogfish make up a very small portion of the landed catch and their biological traits may not be representative of the dogfish landed by other nations. Age-composition data for landings and discards from other nations currently are not available.

> Conclusion: Results from any assessment of dogfish in the Black Sea will remain highly uncertain unless there are concerted and coordinated efforts to collect representative biological samples of dogfish from all fisheries that catch dogfish, including dogfish discarded by fisheries that do not target dogfish.

Red Mullet

Finding: Red mullet is a moderately short-lived demersal species and catches are predominately age-1 and age-2 fish. No information on the discards of red mullet was provided to the Working Group. Most of the reported landings of red mullet since 2004 were taken by Turkey (68%).

Finding: For the period 1996 to 2013 there was a general decline in the annual catches from about 2500 t to 700 t.

Finding: The XSA method was applied to red mullet catch-at-age information from 1990 to 2013 for age-classes 0 to 6+. During the 1990s the SSB was in the range of 5000 - 6000 t, whereas in the recent years it dropped to about 1500-2000 t, and is estimated as being 1173 t in 2013. Fishing mortality has been consistently high since 1990 (0.8 to 1.0), well above the $F_{0.1}$ proxy for F_{MSY} (0.46).

> Conclusion: The EWG endorses the stock assessment for red mullet and considers that the stock was exploited unsustainably in recent years. The catch forecast for 2015 based on the F_{MSY} proxy is 331 t, which is less than the catch forecast under status quo fishing.

Finding: The assessment assumes that red mullet in the Black Sea form a unit stock, but the scientific basis for this assumption has not been established.

> Conclusion: Genetic, morphometric and life-history studies on red mullet in the Black Sea are needed to identify possible stock boundaries.

Finding: The current assessment only has a single tuning index (based on Turkish data) and trends in that index may not be representative of trends in other regions where the stock occurs and is fished.

> Conclusion: Additional tuning series are needed for red mullet.

Atlantic Bonito

Finding: Atlantic bonito is a short-lived pelagic species and the stock in the Black Sea has not previously been assessed. Essentially all of the bonito landings in the Black Sea reported in recent years were taken by Turkey, with small landings also reported by Bulgaria, but there were periods historically when bonito were also caught sporadically by other Black Sea nations. No discard data for bonito were available.

Finding: Turkish fleets catch bonito in the Marmara, Aegean and Mediterranean Seas, but catches occur mostly in the Black Sea. During 1994 to 2013 the average reported Turkish landings of bonito from all seas were large, 15 519 t, and quite variable, ranging from 5521 t in 2004 to 70 797 t one year later, in 2005. About 80% of the Turkish landings were from catches taken in the Black Sea. Only small percentages of Turkish landings were from catches taken in the Aegean Sea (5%) and Mediterranean Sea (3%).

Finding: The Turkish landings of bonito seem to exhibit irregular oscillations with peaks in annual landings occurring about every seven years. The most recent peak, in 2012, was the second highest peak in the landings series and was about half the height of the overall peak annual landing that occurred in 2005.

Finding: The EWG was able to develop an exploratory assessment using the ASPIC biomass dynamics assessment software applied to landings data for bonito caught in the Marmara and Black Seas and corresponding fishing effort data measured in terms of the number of purse-seine vessels. However, it is unclear that the ASPIC biomass production model is capable of mimicking the cyclical stock dynamics that are evident in the landings data.

Finding: In the available length frequency data almost all the bonito were relatively small (< 50 cm) and there were very few large mature individuals, which implies that the adult portion of the bonito population may be unavailable to fishing operations in the Black Sea.

Conclusion: Ichthyoplankton samples from oceanographic surveys and other potential data sources should be explored for evidence that bonito spawn in the Black Sea and to identify spawning seasons and locations.

Finding: In plots of monthly length frequency data it appears that young bonito grow as much as 7-8 cm in one month.

Conclusion: The very rapid growth of bonito implies that age-length keys will need to be developed for very short time intervals (e.g., monthly) if they are to be used to generate reliable estimates of age composition. Age and length data that are aggregated over longer time-intervals will blend adjacent cohorts and produce biased estimates of age-composition.

Finding: The EWG assembled information on the length frequency of the Turkish landings of bonito and developed growth curves. However, the accuracy of the age determinations that underlie the growth curve estimates remains highly uncertain, particularly for the older fish, because of the scarcity of large fish.

Conclusion: Turkey should be encouraged to continue sampling its landings of bonito at a fine temporal scale (e.g., monthly) to provide a base of information that will clarify the growth of bonito and the relative strength of recruiting cohorts.

Rapa Whelk

Finding: Rapa whelk (rapana) is an invasive mollusc that was introduced to the Black Sea in the 1940s. The stock in the Black Sea has not been assessed. Most of the reported landings of rapana since 2004 were taken by Turkey (75%).

Finding: Black Sea landings of rapana reached their peak level of almost 18 thousand tons in 2007, and landings during 2013 increased by 12% from 2012 and were almost 15.5 thousand tons.

Finding: Rapana does not appear to have any natural predators in the Black Sea, but is a predator on native bivalve species such as the oyster (*Ostrea edulis*), the blue mussel (*Mytilus galloprovincialis*) and the striped venus clam (*Chamelea gallina*).

Finding: Most of the catches of rapana are made using dredges or beam trawls. Because these fishing methods disrupt bottom sediments and often produce high rates of bycatch of non-target species, increased harvesting of rapana using dredges or beam trawls is likely to have negative ecological impacts.

Conclusion: The goal for managing rapana should not be to achieve the maximum sustainable yield (MSY). It is not appropriate to constrain fishing activities to achieve high biomass levels of rapana. Fishing for rapana and other actions that will restrict further growth of this stock should be encouraged, even if this means reducing the rapana stock below the level consistent with MSY.

Conclusion: There is great need for an “ecologically friendly” method for harvesting rapana. Fishing for rapana using pots should be encouraged.

Finding: The EWG compiled and examined the available length composition data with respect to their suitability to provide estimates of growth and age composition. It was not possible to distinguish clear indications of cohorts in length compositions tabulated on a monthly or annual basis.

Conclusion: Age determination of rapa whelk is an important technical problem and region-wide harmonization of methods for ageing would be very beneficial for comparative studies of rapana.

Finding: The Turkish length composition data were converted to length at age data using the Ukrainian age-length key, but the results were considered to be unreliable because the Ukrainian rapana, which ranged in shell length from about 40 to 105 mm, were much larger than the Turkish rapana, which ranged in shell length from about 20 to 95 mm.

Finding: The size compositions of the Turkish samples of rapana were markedly smaller than the size compositions of the Ukrainian samples, which is probably due to much higher rates of exploitation of rapana in Turkish waters.

Finding: Rapa whelk remains a data poor stock in the Black Sea.

3. Follow Up Items

The text below highlights some issues that arose during the EWG 14-14 meeting that were created difficulties for the meeting or the process of completing the report. The EWG offers the following suggestions for next year to improve the process for preparing assessments of the Black Sea stocks.

(1) In advance of the next Black Sea EWG meeting there should be a 2-day workshop to develop acceptable and agreed methods for constructing and compiling catch-at-age matrices for use in the EWG assessment meeting. The workshop should identify gaps in essential information (e.g., no age-length keys for segments of the fisheries) and recommend procedures for imputing reasonable estimates for those data gaps and for extending the catch-at-age matrices to include earlier years.

(2) Prior to the next meeting of the Black Sea EWG there should be discussions leading to the development of agreed formats for presenting the stock assessment data and results in a standard, simplified and concise manner, so that the information is more easily accessed and understood by readers of the EWG Report. The quality and readability of a report is often inversely related to its length.

(3) Stock coordinators should compile and review available information that would provide a scientific basis for the stock structure in the Black Sea.

(4) The next assessment of whiting should explore alternative approaches for estimating discards of whiting (e.g., developing whiting discards rates relative to the landed catch of sprat).

4. INTRODUCTION

4.1 BACKGROUND

The European Union (EU) adopted for the first time in 2008 and then for subsequent years catch limitations and associated technical measures for sprat and turbot fisheries in the Black Sea by EU Member States Bulgaria and Romania. Those measures were adopted in the light of scientific advice provided by STECF.

Last year, the STECF Experts Working Group, with representation from four of the six countries that border the Black Sea, met in Ispra (Italy) where relevant data were compiled and stock assessments for the following 9 species were undertaken: sprat, turbot, whiting, Mediterranean horse mackerel, anchovy, piked dogfish, red mullet, Atlantic bonito and rapa whelk.

Five of the stock assessments undertaken, sprat, turbot, whiting, piked dogfish and red mullet were of sufficient quality to provide analytical estimates of recent exploitation rates and stock status in relation to proposed biological reference points. However, the assessment results for whiting and piked dogfish were not sufficiently reliable to provide a basis for short-term catch forecasts.

Regarding other relevant stocks, the assessment for Mediterranean horse mackerel and for anchovy were considered as being indicative of trends only, while the assessments for Atlantic bonito and rapa whelk were considered inconclusive with respect to stock status.

In the light of the above, STECF reviewed gaps in current knowledge and data. Some of the gaps identified were:

• Limited survey coverage to provide tuning indices for the assessments;

• Inadequate sampling of the landings for information on age composition and at sea for information on discards; and

• Uncertainty whether there are multiple stocks of a given species within the Black Sea, and the boundaries that would separate these stocks.

As a final recommendation, STECF suggested to exclude horse mackerel (Trachurus trachurus) and striped red mullet (Mullus surmuletus) in future stock assessment in view of their insignificant catches in the Black Sea.

With a view to improve and update the assessments and catch forecasts compatible with high yields and low risk of stock depletion (i.e. MSY perspective) of the concerned stocks and fisheries in the area, which will be the basis for further management measures, STECF is requested to provide scientific advice on the exploitation levels (i.e. fishing mortalities or alike) and present status and recent development of stocks and the marine ecosystem of the Black Sea and evaluate the existing measures.

With a view to facilitate transfer of knowledge and expertise to the regional multilateral body, it is particularly relevant that to this meeting the GFCM Secretariat will be invited. The results of this meeting will provide valuable information as a basis for further joint analysis and discussions in future GFCM Assessment Working Groups. All these sources of information will provide GFCM-SAC with valuable elements for its scientific deliberations and advice.

Particularly important for the success of the STECF work will be the participation of scientists from non-EU countries (Turkey, Georgia, Ukraine and the Russian Federation), to allow strengthened cooperation for the assessment of shared stocks. However, for the 2014 EWG meeting it may not be possible to obtain participation from Georgia, Ukraine and the Russian Federation.

This EWG workshop will be another step toward a deeper cooperation on fisheries related matters amongst Black Sea scientists which will help feed coastal states' reflections on the direction ahead to improve fisheries management and governance at multilateral level in the Black Sea Region and in the framework of the GFCM.

4.2 Terms Of Reference For Ewg-14-14

Without prejudice, and in recognition that it may not be possible to obtain recent information for fisheries conducted by Ukraine, Georgia and the Russian Federation, STECF is requested to provide advice in particular on 2015 catch forecasts compatible with high yields and lower risk of stock depletion as well as on the state of the most relevant exploited stocks with a view to inform management choices, including technical measures, in line with EU policy objectives and principles for sustainable fisheries management for the stocks listed in Annex I, in line with a MSY perspective. EWG 14-14 is requested to address the following Terms of Reference for Black Sea stocks:

- Compile and provide complete sets of national annual data on landings, discards, landings at age, discards at age, mean weight at age in the landings, mean weight at age in the discards, maturity ogives at age and natural mortality at age by area for the longest time series available up to and including 2013. The data should be compiled based on official data bases, best expert knowledge and by using the results of scientific surveys.
- Compile and provide all fishery independent data (pelagic, demersal, hydro-acoustic surveys) for the stocks as available, their juveniles, eggs or early life stages. In order to allow the use of such data to potentially calibrate virtual population analyses, the abundance, biomass and spawning stock biomass indices at age should be compiled for the longest time series available up to and including 2013.
- Compile and provide complete sets of annual fishing effort data (number of vessels, kW*days, GT*days, fished hours) by nation, for fleets and gears (by mesh size where applicable), and area for the longest time series available up to and including 2013.
- Assess trends in historic stock parameters for the longest time series available up to and including 2013 (fishing mortality at age, spawning stock biomass, stock biomass, recruits at age). Different assessment models should be applied as appropriate, including analyses of retrospective effects.
- Propose and evaluate candidate limit and precautionary reference points consistent with precautionary approach and without undermining the objectives of maximum sustainable yield.
- Review and evaluate existing fisheries management measures and comment on their adequacy to ensure sustainable exploitation of stocks while delivering higher yields and low risk of stock depletion.
- Predict spawning stock biomass, stock biomass, recruits and catches at age and in weight in, 2014, 2015 and the beginning of 2016 under different management scenarios including: (a) status quo fishing mortality (mean F at age 2008-2013, rescaled to 2013) and; (b) fishing mortality that will allow achieving MSY levels at the shortest possible timeframe. Only for turbot and sprat, evaluate the implications of these scenarios on defining autonomous TAC for 2015.
- Up-date the description of fisheries exploiting these stocks, in terms of fleets, fishing gears, deployed fishing effort (capacity in N°-GT-kW, activity in days at sea, gear characteristics), catches and catch composition, size composition, discards, fishing grounds and seasonality.
- Identify knowledge and monitoring gaps for fisheries, stocks, vital fish habitats and other environmental aspects relevant to fisheries in the area and provide information on the reasons for this deficiency and suggest monitoring and scientific actions that need to be developed in the short and mid-term to fill these gaps.
- Evaluate the progress made in addressing such gaps since last year.

- STECF is requested to summarize and concisely describe in detail all data quality deficiencies of relevance for the assessment of stocks and fisheries. Such review and description are to be based on the data format of the official DCF data calls for the Black Sea issued on April 2014.
- Analyse the current state of implementation of surveys in the Black Sea including, where relevant, suggestions to improve their performance in terms of sampling protocols, target species, data gathering, biological parameters estimates and spatio-temporal distribution of the survey effort.
- Prepare and/or up-date maps showing geographic density patterns in annual abundance indices derived from surveys aggregated for age groups selected by the fisheries and compare them with maps of geographical distribution patterns in annual landings and discards of the stocks listed in Annex I by fishing gear.
- Identify other important fisheries and stocks that may be in need of specific management measures to ensure sustainable exploitation and analyse whether the scientific basis is adequate or needs to be further developed.
- Report all results to the STECF Plenary in November 2014 for further scrutiny and endorsement.

Annex I: List of stocks to be assessed

Species common name	Species scientific name	FAO CODE	Priority
Sprat	*Sprattus sprattus*	SPR	High
Turbot	*Psetta maxima*	TUR	High
Whiting	*Merlangius merlangus*	WHG	High
Piked dogfish	*Squalus acanthias*	DGS	High
Red mullet	*Mullus barbatus*	MUT	Medium high
Anchovy	*Engraulis encrasicolus*	ANE	Medium high
Mediterranean horse mackerel	*Trachurus mediterraneus*	HMM	Medium
Rapa Whelk	*Rapana venosa*	RPW	Low
Atlantic Bonito	*Sarda sarda*	BON	Low

5. UPDATE AND ASSESS HISTORIC AND RECENT STOCK PARAMETERS (SUMMARY SHEETS)

5.1 SUMMARY SHEETS

5.1.1 SUMMARY SHEET OF SPRAT IN GSA 29

Species common name: Sprat
Species scientific name *Sprattus sprattus*
Geographical Sub-area(s) GSA(s): GSA 29

Available Fishery-Dependent Data

Landings data were provided by Bulgaria, Romania, Ukraine, Turkey and the Russian Federation based on official national statistics. No data from Georgia were available. Bulgaria provided also landings data based on expert judgement for 1992 – 2011. Landings-at-age, landings-weights-at-age and fishing effort were provided by Romania through the Data Collection Program (DCR199/2000 EC), whereas Bulgarian data on sprat were provided through other sources. Discards are reported only for Romania for the 2011 -2013 as for the late year they are increased. There was no maturity estimations reported in 2012.

The data are believed to be of sufficient quality to conduct an assessment for sprat in the Black Sea.

Fisheries

The sprat fishery takes place in the Black Sea (GFCM Fishing Sub-area 37.4 (Division 37.4.2) and Geographical Sub-area (GSA) 29). In Bulgarian, Romanian, Russian and Ukrainian waters the most intensive fisheries for Black Sea sprat are conducted in April to October with mid-water trawls on vessels 15- 40 m long and a small number vessels greater than 40 m. The main fishing gear is midwater trawl and the mesh size of the codend is 6.5-7 mm. Harvesting of Black Sea sprat is conducted during the day when the sprat aggregations become denser and are successfully fished with mid-water trawls. Other fishing gears targeting sprat are beach seines and uncovered pound nets.

Table of sprat landings (tons) in the Black Sea. The Detailed Assessment includes landings data since 1970.

year	Bulgaria	*Bulgaria	Romania	Ukraine	Turkey	Georgia	Russian Federation	Total
1980	16568		989	47635	0	4571	14687	84450
1981	1888		2283	49175	0	5781	20165	79292
1982	16524		3004	3862	0	2462	15266	41118
1983	12023		3406	20755	0	886	3843	40913
1984	13921		4456	18021	0	847	5270	42515
1985	15924		6836	23657	0	1817	3365	51599
1986	1169		8979	33147	0	2939	7010	53244
1987	10979		9474	43158	0	697	8972	73280
1988	6199		6454	39835	0	7172	7157	66817
1989	7403		8911	63239	0	9708	16045	105306
1990	2651		3198	33174	0	6895	6955	52873

1991	1909		729	11094	0	2313	2675	17082
1992	2353	3266	2074	11492	0	830	3221	20883
1993	2174	3705	2439	9154	640	32	694	16664
1994	2200	3500	2203	12615	700	308	1013	20339
1995	2874	3200	1982	15218	157	288	1263	22108
1996	3535	3500	2014	20720	937	185	1537	28893
1997	3646	3646	3318	20208	468	85	706	28431
1998	3275	3275	3293	30282	1236	24	1243	39353
1999	3595	3595	1933	29238	421	45	4473	39705
2000	1737	3500	1803	32644	6225	42	5543	49757
2001	695	6961	1792	48938	1008	40	11122	69861
2002	11595	11595	1617	45430	1965	34	11218	71859
2003	9155	9155	1219	31366	5775	2	204	47721
2004	2889	79979	135	30891	5186	12	143	44364
2005	2575	6500	1487	35707	5271	19	1316	50300
2006	2655	8183	492	21308	6681		8157	44821
2007	2559	2985	208	18013	11725		6077	39008
2008	4304	4304	234	21111	39903		7814	73366
2009	4551	4551	92	24603	53385		8744	91375
2010	4041	4041	39	24652	57023		5839	91594
2011	3958	3958	131	24379	87141		5099	120708
2012	3157		88	15751	12092		3937	35025
2013	3784		99		12866	9677	842	27268

The complete set of fishery-dependent data is presented in the detailed assessment (6.1.).

Available Fishery-Independent Data

A pelagic survey under DCR 199/2000 was conducted in spring 2013 only in the Romanian marine area.

During the surveys the collected information includes length (TL), weight, sex composition and maturity. Otoliths for age determination are collected and discards will be investigated. Each survey includes 30-40 mid-water trawl hauls for 8-10 days. The pelagic trawl has the following dimensions: 57/63-62m, with horizontal opening of 22m. The average speed of the vessel was of 2.5 knots. The trawling time was standardized at 60 minutes, being realized 32 hauling. Average catch (t/Nm2) in strata 0-30m was 23.97 t/Nm2; 30-50m – 4.94 t/Nm2 and 50-70m – 3.37 t/Nm2. The calculated biomass in Romanian shelf was of 56 428 tons.

The biomass estimations from scientific surveys using Swept area and hydro acoustic methods in EU waters of the Black Sea for 2008-2013 are presented as follows:

Biomass, t	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***
Bulgarian waters	*32718.3*	*41761.4*	*75080.2*	*48201.7*	-	-
Romanian waters	*60000*	*60000*	*59600*	-	*68886*	*56428*

The biomass of the species is remarkably higher in the eastern part of the area surveys. The averaged biomass is estimated as 6.4 tons/na2 (423 552 tons within the Turkish EEZ). However this values should be treated with care as the TS (B20=-71.2) value used to convert NASC to abundance is taken from (your sprat publication) to ensure comparability. Hydroacoustically estimated biomass was 6.4 tons/na^2. TSmean = - 57.4 (based on B20=-71.2).

The compiled fishery-independent data are presented in the Detailed Assessment (6.1).

Summary Maps

The data in 2013 regarding geographical distribution were obtained from a pelagic survey conducted in Romanian waters of the Black Sea during early summer and hydroacoustic survey conducted in summer of 2013 in Turkish marine waters.

The distribution maps are presented in the Detailed Assessment (6.1.)

Fishing Effort

Under DCR 199/2000 Bulgaria, for 2013 reported 69 vessels operating with OTM with nominal effort of 770065 and GT days-at-sea of 69455.59.The vessels operating FPO were 32, with nominal effort of 22308.16 and GT days-at-sea 2352.03, respectively. Romania reported 4 vessels operating with OTM with nominal effort of 56303 and GT days-at-sea of 11701. The fishing vessels operation with FPN gears in Romania in 2013 was 27, with nominal effort of 199346 and GT days-at-sea of 38902, respectively.

There was a large amount of fishing effort by the Turkish fleet starting in 2005, 2006, 2007 and occurring especially in the 2008, 2009, 2010 and 2011 fishing periods. However, the sprat landings sharply decreased in 2012. Trends in total catch were similar to the increase in the number of vessels. While total landings were about 1000-3000 tons at the end of 1990s, the reported landings were only 50, 60 and 80 thousand tons during 2009, 2010 and 2011 respectively. There then followed another decreasing trend during last two fishing seasons in 2012 and 2013. Engine power ranges between 140 HP and 970 HP. The mean engine power of this fleet is approximated as 415.7 HP and the mode appears around 300 HP. The mesh size in pelagic trawl nets used in the sprat fishery is 12 mm in the Samsun Shelf Area. One can conclude that the actual fishery using the 12 mm mesh size does not have any negative impact on the immature sprat population, which can be defined as being confined to the Samsun Shelf Area.

The compiled fishing effort data are presented in the Detailed Assessment (6.1).

Stock Assessment Summary

The stock was assessed using the Integrated Catch Analysis method applied to catch-at-age data from 1993 to 2012. During this period there were large changes in the catch, which increased steadily from a low level of about 17 thousand tons in 1993 to a first peak level of about 72 thousand tons in 2002, and a subsequent peak of almost 121 thousand tons in 2011. The series of spawning biomass estimates also had two peak values, but they occurred in 2001 and 2009, and both peaks were about 500 thousand tons. The series of recruitment estimates similarly had two peaks, of similar size, but in 1999 and 2008.

Most recent state of the stock

State of the spawning stock size: According to the present assessment in recent years the SSB is at medium levels (180 000-300 000 t) with a decreasing trend since 2010. In 2013, the SSB has dropped to 179 464 t. Under a constant recruitment scenario and status quo F = 0.446, in 2014 the SSB is expected to increase to 198 189 and to decrease to 185 093 t by 2016.

State of recruitment:

Recruitment reached a low in 2010-2011 and since then started to increase. Recruitment estimates are rather imprecise due to the lack of survey data. In short-term forecast we used a geometric mean over the 2010-2012 values, equal to 99 217 596.

State of exploitation:
Over the last few years the fishing mortality has peaked in 2010-2012 at a level of 0.7 - 1.24. Proposing a limit reference point of exploitation rate E≤0.4 that equals F = 0.64 (as suggested by Patterson 1992 for short living fish), the EWG considers that the catches where too high over 2010-2012, that supported the decreasing trend in SSB. The current (2013) F=0.446 has resulted from an about 4 times drop in total catches since 2011 when the catches peaked at 120 710t. Status quo fishing implies catches in the range of 36 397 - 34 200 t over 2014 - 2016 which are bellow the recommended catch of 48 755 t, at Fmsy.

Source of data and methods:
International landings data at age were constructed and the Integrated Catch Analysis (ICA) assessment method was applied. Discards of sprat are believed to be low, but the fishery for sprat is thought to produce appreciable (but unquantified) amounts of discards of other species (e.g., whiting). Short term predictions were based on a short term geometric average recruitment.

Complete stock assessment results are presented in the Detailed Assessment (6.1).

Existing management measures
Catch quotas for EU waters of the Black Sea were allocated as follows for 2011 - 2013: 8 032.5 t to Bulgaria and 3 442.49 t to Romania. No fishery management agreement exists among the other Black Sea countries. Turkey has adopted several kinds of regulation for its sprat fisheries: regulations about fishing areas, fishing gear, fishing seasons, and depth restrictions

Details about the management measures and regulations are provided in the Detailed Assessment (6.1).

Short and medium term scenarios:
A short term prediction of stock size and catches, assuming a sustainable status quo fishing scenario, has been provided together with a range of management options. Considering the short life span of sprat in the Black Sea and the high variation in estimated recruitment, the EWG emphasises that the short term projections were based on the geometric mean of recent recruitment and the resulting catch projection is subject to high uncertainty. The poor knowledge about the recruitment dynamics prevented the formulation of medium term projections.

The status quo fishing in 2014, with F(1-3) = 0.446, would result in landings of 35 678 and SSB of 198 971 t. Thus the 2014 SSB is forecasted to increase by about 11% and total catch is forecasted to increase by about 30%, compared to 2013. With fishing at F_{MSY} = 0.64 (corresponding to an exploitation rate of 0.4) forecast catches are 48 755 t in 2015 and 42 558 in 2016. and SSB is declining from 188 624 t in 2015, to 174 413 t in 2016.

The complete stock assessment projections are presented in the Detailed Assessment (6.1).

Limit and precautionary management reference points
Table of limit and precautionary management reference points proposed by STECF EWG 14-14.

E (mean)	≤ 0.4

Table of limit and precautionary management reference points agreed by fisheries managers.

F_{msy} (age range)=	none
B_{pa} (B_{lim}. spawning stock)=	none

Comments on the assessment

Data and Information Gaps

The EWG 14-14 suggests that an international hydroacoustic survey is needed to monitor the condition of sprat across all waters of the Black Sea, including the national waters of Bulgaria, Romania, Georgia, Russia, Turkey and Ukraine.

There is concern that the fishery for sprat produces significant quantities of bycatch and discard of other fish species (e.g., whiting, turbot, dogfish, and other species). The EWG suggests that there should be increased sampling of the sprat fishery by at-sea observers to quantify the amount of bycatch and discarding.

Progress since last Year in Addressing Gaps

The EWG report last year also suggested that an international survey was needed for the entire Black Sea region. There was no progress during the past year to develop such a survey.

5.1.2 SUMMARY SHEET OF TURBOT IN GSA 29

Species common name: Black sea turbot
Species scientific name *Psetta maxima / Scophthalmus maximus*
Geographical Sub-area(s) GSA(s): GSA 29

Available Fishery-Dependent Data

Landings, landings-at-age, landings-weights-at-age and fishing effort of Romania were reported through the EU Data Collection Program. Bulgaria reported only landings and fishing effort through the EU Data Collection Program. The landings-at-age and landings-weights-at-age for Bulgaria were provided from other national surveys. Landings data for Turkey, Ukraine and Russia were provided from the official statistics of each country. The landings-at-age and landings-weights-at-age of Turkey and Ukraine were provided from projects and other sources. Turkey reported fishing effort data for 2013 resulting from a survey on commercial vessels. There was no available information from Georgia.

Based on the assumption that the sudden drop after 2001 in the annual landings by Turkish vessels operating in the western portion of the Black Sea was replaced by unreported catches of turbot by Bulgarian, Romanian and Ukrainian fishers,the IUU catches in 2002-2013 were estimated by rising the cumulative landings of Ukraine, Romania and Bulgaria by a proportion given by the following expression: (mean Turkish landings in 1993-2001 - mean Turkish landings in 2002-2010) divided by the mean cumulative landings by Ukraine, Romania and Bulgaria in 2002-2010. The estimated ratio is 4.7, which implies that IUU catches in Ukrainian, Romanian and Bulgarian waters since 2002 were about 5 times larger than the reported official landings.

Fisheries

The turbot stock in the Black Sea during 2013 was exploited by stationary (bottom set gillnets) and mobile fishing gears (bottom trawls). In Romania, 76 vessels were involved in the turbot gillnet fishery, with a total effort of 2371 fishing days. An increase of 15% in number of vessels and 50% of days at sea in Romania was observed. In Bulgaria, the total number of approved vessels involved in the turbot fishery in 2013 was 124 with a reduction of the number of boats more than 3 times due to change in system for management and distribution of national quota between vessels. The total number of vessels, operating in the turbot fishery in Turkey was 486 in 2013, 154 fishing in Samsun Shelf Area/SSA and 332 in West Turkish Black Sea. The observed increase in number of Turkish vessels was around 34%. For the rest of the countries, no data were available for the fishing fleets operating on turbot.

Official landings and landings including IUU estimates of turbot in the Black Sea during the period 1989 – 2013.

Year	Bulgaria	Romania	Ukraine west	Ukraine east	Turkey west	Turkey east	Russia	Georgia	Total Black Sea (official)	Total BS with IUU
1989	0.9	0	2	0	448	1001	0	8	1459.9	
1990	0	0	9	0	908	475	0	1	1393	
1991	0	2	17.1	0.9	600	315	0	0	935	
1992	0	1	18	1	308	110	1	0	439	
1993	0	6	10	0	400	1185	2	0	1603	
1994	0	6	18	1	1293	821	5	0	2144	
1995	60	4	10	0	2006	844	19	0	2943	
1996	62	6	37	2	1414	510	17	0	2048	
1997	60	1	40	2	777	134	11	0	1025	

1998	64	0	40	2	1056	412	14	0	1588	
1999	54	2	69	4	1579	225	15	5	1953	
2000	55.1	2	76	4	2321	318	4	9	2789.1	
2001	56.5	13	123	6	2169	154	24	11	2556.5	
2002	135.5	16.68	99	5.47	193	142	15	11	617.651	1567.3
2003	40.8	23.98	118	5.876	126	93	15	1	423.654	1121.7
2004	16.2	42.03	126	7.157	118	116	1.7	7	434.088	1142.2
2005	12.69	36.53	123	6	273	275	7.5	7	740.72	1400.1
2006	14.81	35.11	154	8	266	481	7.6	0	966.52	1750.6
2007	66.85	48.06	205	10.58	346	353	5.7	0	1035.4	2259.0
2008	54.62	47.11	239	12.35	224	234	4.7	0	815.79	2122.2
2009	52.47	48.77	247	16	223	119	24.3	0	730.54	2078.2
2010	46.45	48.25	166	41	218	77	25	0	621.7	1738.0
2011	37.8	43.25	211	25	108.1	36.4	24.09	0	485.64	1658.7
2012	36.38	43.21	223.03	17.91	172.2	0	35.27	0	527.99	1713.9
2013	39.58	43.2	181.03	12.34	118.6	75	30	0	499.76	1521.53

The complete sets of compiled fishery-dependent data are presented in the Detailed Assessment (6.2).

Available Fishery-Independent Data

One national demersal trawl survey was executed in 2013 under the EU Data collection Framework program and covers the Romanian Black Sea area during spring and autumn. Estimated numbers at age were used to compile the data set used for tuning in the assessment.

The compiled fishery-independent data are presented in the Detailed Assessment (6.2).

Summary Maps

Summary maps were provided for the biomass indices (CPUA ($kg*Nm^{-2}$)), derived from the demersal trawl surveys carried out in spring and autumn in Romanian Black Sea area and the CPUE derived from commercial fishing vessels in Turkey.

Fishing Effort

The increase of 15% in number of vessels and 50% of days at sea was observed in the Romanian Black Sea area, compared to 2012. In Bulgaria, the number of vessels involved in turbot fishery was reduced by a factor of 3. In Turkish Black Sea area, the number of fishing vessels operated in turbot fisheries increased 34%.

The compiled fishing effort data are presented in the Detailed Assessment (6.2).

Stock Assessment Summary

State of the spawning stock size:

The assessment indicates that the spawning stock biomass continues to be at very low level (around 1634 t) and it is estimated to be around half of B_{lim} (3535 t). F in 2013 (1.33) is more than five times higher than F_{msy} (0.26).

State of recruitment:

Recruitment peaked during the period 2004 - 2007 and decreased thereafter.

State of exploitation:

The STECF EWG 14 14 estimated F_{msy} to be equal to 0.26 (i.e. F which maximises average catch in the long run) as the limit reference point consistent with high long term yields. In 2013, the F is 1.33, more than 5 times the F_{msy}. The EWG classifies the stock of turbot in the Black Sea as being exploited unsustainably and at risk of collapse. STECF EWG 14 14 considers that on the basis of precautionary considerations there should be no directed fisheries for turbot in 2015 and bycatch should be minimised.

Most recent state of the stock

- State of the adult abundance and biomass (SSB): SSB is still at very low level (around 1634 t) and it is around of a half of the estimated B_{lim} (3535 t).
- State of the juveniles (recruits): The low abundant recruitment after 2007 is not able to result in significant increase of SSB during the recent years.
- State of exploitation: In 2013, the F is at the high level around 1.33, more than 5 times F_{msy} (0.26).
- Source of data and methods: The data set for the period 1950-2013 was compiled using the historical data sources and new data for 2013. Available data of total landings, catch at ages, weights and maturity at age are considered appropriate for assessing the stock using the state-space assessment model (SAM) (Nielsen et al., 2012). All assessments were performed with version 0.99-3 of FLSAM, together with version 2.5 of the FLR library (FLCore). Five tuning series (4 surveys and 1 commercial CPUE series) were compiled from previous assessments and recent data.

The complete stock assessment results are presented in the Detailed Assessment (6.2).

Outlook and management advice

Short and medium term scenarios:

Fishing at the current level of F (1.33) from 2014 to 2015 generates a reduction of the catches of 0.08 % and a decrease of the spawning stock biomass of 0.04% from 2015 to 2016.

Fishing at F_{MSY} (0.26) from 2014 to 2015 generates a decrease of the catch of 70.55% and a spawning stock biomass increase of 39.16 % from 2015 to 2016.

Catches of turbot in 2015 consistent with F_{MSY} (0.26) should not exceed 213 tonnes.

In case of zero catches in 2015, the SSB is expected to increase 47.6 % in 2016.

The STECF EWG 14-14 did not undertake medium term predictions.

The complete stock assessment projections are presented in the Detailed Assessment (6.2).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 14-14

F_{msy}	0.26
B_{pa}	4949
B_{lim}	3535

Table of limit and precautionary management reference points agreed by fisheries managers

F_{msy} (age range)=	None
B_{pa} (B_{lim}, spawning stock)=	None

Existing management measures

Turbot fisheries in Black Sea EU waters are being managed through the annual establishment of fishing opportunities (EU quotas) since 2008, by the adoption of Council Regulations. During the last four years, the EU turbot quota has been fixed at 86.4 t and allocated to Bulgaria and Romania (50% each). The same Council Regulations set up every year the prohibition of fishing activities during the reproduction period for turbot. The ban has been in force from 15 April to 15 June in European Community waters of the Black Sea. The same period of prohibition is fixed by Turkish National Legislation.

At the national level, different technical or management measures are in force in Bulgaria, Romania, Turkey and Ukraine.

A complete description of management measures is presented in the Detailed Assessment (6.2).

Comments on the assessment

Data and Information Gaps

The main gaps in the fishery dependent data sets are related to the quality of the official landings and effort data, the unknown rates of discards and IUU catch. Landings at age were not available for Russia and were derived using the Ukrainian estimated age composition. No data were available for Georgia.

Stock identification and stock boundaries are still not well defined and for the time being the turbot population in the Black Sea is assessed as a single stock. Genetic and tagging studies are essential for the definition of the population structure of turbot in the Black Sea.

Lack of annual research surveys, covering the whole distribution area of the turbot population in the Black Sea continues to exist, moreover in 2013 only one survey, covering the Romanian Black Sea area was carried out. Harmonization in survey methods and age reading procedures is necessary, but was not achieved in 2013.

Progress since last Year in Addressing Gaps

There was no progress in overcoming past gaps.

5.1.3 SUMMARY SHEET OF WHITING IN GSA 29

Species common name: Whiting
Species scientific name *Merlangius merlangus*
Geographical Sub-area(s) GSA(s): GSA 29

Available Fishery-Dependent Data

The basis for the Whiting assessment is the data set prepared at EWG 14-14 with new data added for 2013.

National annual data on landings (tons). There is a full data set for the period 1980 to 2011. For 2013 data are available for all Black Sea nations with the exception of Georgia. Landings from the Black Sea during 2013 were 8,281 t, which is close to the landings in 2011 (8,222 t), and lower than the 2012 landings (6,332 t).

Discards (tons). Data on the discards of whiting are available as follows: from Bulgaria for the period 1980 to 1993; from Ukraine for the period 1992 to 2002; from Romania only for 2011-2013. Discard data for Georgia, the Russian Federation and Turkey are absent. The reported discards of whiting during 2013 were 19.9 t.

Landings at age (numbers of fish) and mean weight at age in the landings (kg / fish). Data on catch-at-age and weight-at-age are available for the period 1994 to 2011, but the information is sparse and has many gaps. The Romanian data are available only since 2002; the Turkish data are available for five years (2000, 2002, 2010, 2011, 2012 and 2013), Georgian and Russian data are absent. Missing data were reconstructed for these countries and are based on expert judgement. For 2013, data are available, with the exception of Georgia.

Discards at age (numbers of fish). Data are available only for Romania (2011, 2012 and 2013) and Ukraine (1994-2002). In Turkish waters (Samsun shelf area) information was available on the rate of whiting discards observed in 2005 - 2012 but with no details of the age composition.

Mean weight at age in the discards. Data are available only for Romania (2011, 2012 and 2013).

Maturity ogives at age and natural mortality at age by area. Maturity ogives at age for 1994-2012 are based on averages for fish from Romania and Ukraine. For 2013 a whiting maturity ogive was available only for fish from Turkey. Estimates of whiting natural mortality by age are available only for the period of 1980-1990s.

Description of the Fisheries

In the Black Sea, Turkey is the only country where whiting is a target for fisheries. Thus, about 99% of the catch of blue whiting since the 1990s has been caught by Turkey, although the Turkish portion of the continental shelf in the Black Sea does not exceed 10%.

There are four fishing methods for whiting along the Turkish Black Sea coast. The first is trawl nets with a catch of 82.1% of total catch and a mean fish length of 16.1 cm. Gill nets are also used harvest whiting and account for 13.6% of the total catch with a mean fish length of 18.2 cm. The rest (3.7%) of the whiting catch is caught by purse seines and 0.6% by lines with mean catch lengths of 16.0 cm and 19.6 cm respectively. Bottom trawl is the major fishing method for whiting.

The data set of landings was compiled for the period 1970 – 2013. The following table lists the landings (tons) by nation for 1980 - 2013.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Union Soviet Soc. Rep.
1980	30	-	618	-	6838	1102	2690
1981	1	-	894	-	4669	2083	2238
1982	4	-	800	-	4264	825	1513
1983	0	-	1080	-	11696	817	2381
1984	0	-	1192	-	11595	2252	4738
1985	0	-	3138	-	16036	1101	2655
1986	0	-	1949	-	17738	1867	2652
1987	0	-	615	-	27103	579	2764
1988	0	5	1009	736	28263	1482	2223
1989	0	5	2739	7	19283	584	-
1990	0	0	2653	235	16259	87	-
1991	0	0	59	210	18956	24	-
1992	0	70	1357	37	17923	0	-
1993	0	172	599	16	17844	4	-
1994	0	187	432	125	15084	64	-
1995	0	146	327	91	17562	17	-
1996	0	223	389	11	20326	3	-
1997	0	58	441	10	12725	29	-
1998	0	53	640	119	11863	55	-
1999	0	41	272.4	184	12459	18	-
2000	9	36.5	275.0	341	15343	20	-
2001	8	32	306.0	642	7781	18	-
2002	16	37*	85.0	656	7775	9	-
2003	13	45	113.4	93	7062	21	-
2004	2	29	117.6	55	7243	43	-
2005	3	30	93.3	78	6637	30	-
2006	2	37	96.7	60	7797	15	-
2007	16.1	41	17.1	22	11232	64	-
2008	0.4	15	55.2	96	10986	9	-
2009	2.3	15*	39.5	52	8979	17	-
2010	14.7	15*	23.6	23	11894	17	-
2011	1.0	42	0.1	20.9	8122	36	-
2012	1.4	42*	0.4	2.8	6251.4	34	-
2013	5.3	-	1.1	15.0	8240.0	20	-

* based on expert judgement

The complete sets of compiled fishery-dependent data are presented in the Detailed Assessment (6.3).

Available Fishery-Independent Data

Survey tuning indexes of whiting abundance are reported for the Romanian research trawl surveys in 2007 - 2013. Tuning indices based on Turkish surveys of commercial vessels are available for 2009-2013.

The compiled fishery-independent data are presented in the detailed assessment section (6.3).

Summary Maps

Geographical distribution patterns of whiting in Romanian waters in 2013 for spring and autumn are given in the detailed assessment section (6.3). Also provided for 2013 are maps of the distribution of the whiting agglomerations (and corresponding biomass indices) along the Eastern Black Sea coasts of Turkey (the Samsun Shelf Area) and the Western Black Sea.

Fishing Effort

No information on fishing effort was provided to the EWG 14-14.

Stock Assessment Summary

Most recent state of the stock

Stock assessment was conducted using the XSA method applied to catch-at-age information from 1994 to 2013 for age-classes 2 to 8^+. As in the 2013 assessment, high and erratic levels of discarding of age-0 and age-1 whiting prevented incorporating these age-classes into the catch-at-age matrix. During this period the annual catch weight (age - 2 to age - 6^+) varied around an average of about 7,000 t during the first 10 years but then declined to the lowest point of the series (2,159 t) in 2005. Annual catches rose steadily for the next five years to a peak value of almost 17,000 t in 2010 and then declined. Catch during 2013 was slightly less than 8,200 t.

- <u>State of the adult abundance and biomass (SSB):</u>

From 1994 to 2013 for age-classes 2 to 8^+ the SSB varied cyclically with peaks in 2000 and 2009, but the SSB estimate for 2013 is the lowest of the series (20,000 t). Given the absence of a biomass reference point, the EWG 14-14 is unable to fully evaluate the stock status with respect to it.

- <u>State of the juveniles (recruits):</u>

EWG 14-14 is unable to fully evaluate the state of recruitment due to the selection of only age 2-8^+ for the assessment. The available information on age - 0 and age - 1 fish was considered unreliable because there have been significant (but unquantifiable) amounts of discards of young whiting.

- <u>State of exploitation:</u>

The EWG 14-14 proposed F_{MSY} (1-4) ≤ 0.4 as the limit reference point consistent with high long term yields and low risk of fisheries collapse, based on $F_{0.1}$ as an F_{MSY} proxy. As the estimated F(2-4) = 1.154 exceeds this Fmsy, the EWG 14-14 classifies the stock of whiting in the Black Sea as being potentially exploited unsustainably. However, given the uncertainty regarding the amount of discards, the assessment results are mainly indicative of trends.

- <u>Source of data and methods:</u>

International landings at age were constructed for 1994 - 2013, but data on discards by age are incomplete for 1994-2002 and 2011-2013, and completely lacking for 2003 - 2010. The XSA analyses were tuned to data from a Romanian bottom trawl survey in 2007 - 2013 and by a second survey from Turkey for the period 2009 - 2012. Catch weight at age matrices were averaged across countries to derive a single mean weight at age matrix. Data from age-classes 0 and 1 were excluded from the XSA to reduce the influence of poor or missing estimates of discards of age - 0 and age - 1 whiting. The assessment was run using ages 2 to 8^+ for the both the catch matrix and the tuning indexes.

The complete stock assessment results are presented in the Detailed Assessment (6.3).

- Existing management measures

Information regarding management measures for 2013 is available for all the Black Sea nations with the exception of Georgia and the Russian Federation. For the rest of the riparian countries of the Black Sea region the fishery management measures for whiting include minimum landing sizes, closed areas, closed seasons and other technical measures.

In the waters of Turkey, from which the major portion of Black Sea whiting are taken, there are no annual quotas or restrictions on fishing effort, and the permitted mesh size in trawls and gillnets does not meet the scientific recommendations. It is likely that inadequate Turkish fishery management measures have contributed to the overfishing of whiting that has apparently occurred in recent years.

A complete description of management measures is presented in the Detailed Assessment (6.3).

Outlook and management advice

Short and medium term scenarios:

The EWG 14 14 did not undertake medium term projections.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 14-14

Fmsy(1-3) proxy derived from F0.1	≤ 0.4

Table of limit and precautionary management reference points agreed by fisheries managers

F_{msy} (age range)=	None
B_{pa} (B_{lim}, spawning stock)=	None

Long term projections

The EWG 14 14 did not undertake long term projections.

Comments on the assessment

Data and Information Gaps

The EWG 14-14 identified the following knowledge and monitoring gaps regarding the whiting stock assessment:

- incompleteness and breaks in the historical data series of landings, discards, landings-at-age, discard-at-age, landing weights-at-age, discard weights-at-age, natural mortality by age;
- discrepancies in determining the age of fish older than two years;
- lack of data collection on fishing effort that targets whiting;
- lack of national and international trawl/hydroacoustic surveys that cover an adequate portion of the area inhabited by whiting in the Black Sea.

EWG 14-14 suggest a series of monitoring and scientific actions that need to be developed in the short and mid-term to fill these gaps:

- to revise the existing national historic data on the length and age composition;
- to organize one or more workshops for the inter-calibration of age readings between different laboratories and scientists in the region;

- to explore the possibility (including financial support) of an international trawl/hydroacoustic survey that cover the whole area of distribution for the main demersal fishes in the Black Sea

Progress since last Year in Addressing Gaps

No progress was made in improving the data quality and the assessment from last year.

5.1.4 SUMMARY SHEET OF MEDITERRANEAN HORSE MACKEREL IN GSA 29

Species common name: Mediterranean horse mackerel
Species scientific name *Trachurus mediteraneus ponticus* Aleev
Geographical Sub-area(s) GSA(s): GSA 29

Available Fishery-Dependent Data

Landings data for Bulgaria, Romania, Turkey, Ukraine and Russia were provided from the official statistics of each country. Some of the horse mackerel biological data are lacking. The only available data for landings at age, mean weight at age in the landings, and maturity at age are for the period 2004-2013. Landings at age and weight at age were not available for the Russian Federation and Georgia, and were derived using Ukrainian estimated age and weight composition.

Description of the Fisheries

Black Sea horse mackerel were caught by active (bathypelagic trawls and surrounding nets) and passive fishing gears (gill netting, trawl net, trap nets). Horse mackerel stocks in the Black Sea are usually caught by Turkish fishermen using active (bottom trawler, pelagic trawler and large bag-shaped nets) and passive (extension and longline) nets. Almost the whole horse mackerel catch (98.2%) is caught by large bag-shaped nets. A large part of the catch (80%) in Turkish waters is caught in the autumn and the first part of winter (September-December).

Landings data were compiled for the period 1950 – 2012, but are only shown for 1980 – 2012 in the table below. During the period 1956 – 1965 catches grew and reached a mean value of 19 008 tons. During the period 1966 – 1975 the total average catch increased to 21 042 tons. During the next decade (1976 – 1985) the horse mackerel catches again increased, from 20 576 to 141 078 tons. During the period 1986 – 1995 there was an abrupt decline in the catches from 97 741 to 15 906 tons. The next seven years (1996 – 2002) was a period of prolonged decline in the horse mackerel catch, reaching a mean value of 12 344 tons. In 1992 a catch of 21 065 t was achieved. From 1994 the amounts of catches decreased, especially during 1998-1999. In 2012 a considerable increase in the catches of horse mackerel was reported, to the level of 24 931 t, but in 2013 the reported catches declind to 20213 t.

The following table list the landings (tons) by nation.

Table 5.1.4.1 Landings by country. The Detailed Assessment includes landings since 1950.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Total
1980	813.0	-	1536.0	-	42339.0	-	45297.0
1981	476.2	-	588.0	-	40543.0	-	41951.2
1982	366.8	-	291.0	-	48918.0	-	51450.8
1983	496.7	-	1510.0	-	54548.0	-	63711.7
1984	1015.8	-	872.0	-	69980.0	-	77369.8
1985	755.8	-	1035.0	-	100417.0	-	141077.8
1986	850.9	-	945.0	-	100943.0	-	105108.9
1987	826.4	-	997.0	-	90850.0	-	93216.4
1988	1676.8	-	2660.0	-	93006.0	-	977408
1989	1100.9	-	1459.0	-	94023.0	-	96887.9
1990	164.1	-	165.0	-	65163.0	-	65548.1
1991	122.9	48	0	-	19781.0	-	19954.9
1992	54	0	22	0	20989	0	21065
1993	31	0	30	0	23945	0	24006
1994	80	0	35	1	25275	1	25392

1995	70	0	24	1	15809	2	15906
1996	68	0	10	0	16093	0	16171
1997	36	18	1	0	11097	5	11157
1998	40	13	15	2	8246	0	8316
1999	30	0	3	2	8331	1	8367.2
2000	111	35	8	2	16181	0	16336.8
2001	130	7	17	6	16750	1	16911
2002	141.5	19	21	28	8903	34	9146.5
2003	141.6	70	10	77	9213	745	10256.6
2004	73.9	56	14	105	9113	272	9633.9
2005	29.4	60	12	169	17003	329	17602.4
2006	62.8	55	19	200.5	12812	476	13625.3
2007	115.9	53	14	63.2	17429	211	17886.1
2008	179.6	8	11	154.2	20124	366	20842.9
2009	176.9	6*	17	124.0	15905	260	16489.1
2010	165.3	5*	7	108.9	12929	190	13405.5
2011	394.8	44**	22.8	87.2	17746	264	18558.9
2012	381.4	44	20.0	69.5	23911.2	539.7	24931.4
2013	271.4	0	26.3	89	18979.4	847.4	20113.5

Available Fishery-Independent Data

No survey information on horse mackerel was provided to the EWG 14-14.

Summary Maps

No data were available to prepare detailed maps of the distribution of horse mackerel and its fisheries.

Fishing Effort

No information on fishing effort was tabled during the EWG 14-14 meeting.

Stock Assessment Summary

- State of the adult abundance and biomass (SSB):
  Assessment formulations indicate that the SSB in 2013 is decreasing compared to previous years. In the absence of total stock size estimates and biological reference points, EWG 14-14 is unable to fully evaluate the stock size with regard to the precautionary approach.

- State of the juveniles (recruits):
  Recruitment is indicated to have varied without a clear trend since 2004.

- State of exploitation:
  Given the current assessment of horse mackerel in the Black Sea, F_{2013}= 1.42. Since the stock is pelagic, as a reference point the Patterson Exploitation E=0.4 was selected to be consistent with long term exploitation of the stock. The E_{2013}= 0.78 is almost two times higher than the reference point, thus the stock is in state of overexploitation in 2013 and since 2005 (section 6.4).

- Source of data and methods:
  The EWG14-14 endorses the stock assessment for horse mackerel given the improvements over previous year's assessments, which were not endorsed. The main reason for accepting the current XSA assessment is the availability this year of a tuning index based on commercial CPUE data from a Turkish fleet, which is considered reliable and is deemed appropriate for tuning the

bulk of the catches coming from the Turkish series. There are however two limitations with this CPUE: first, the CPUE is an index of aggregated biomass split with the age structure of the catch matrix from Turkey; second, the yearly biomass index is derived by summing the monthly CPUEs rather than averaging across months. Finally, a commercial CPUE index derived from purse-seine catches and standardized to kg/vessel/day is a very raw index since it does not account of search time, number of sets, boat size etc. A much better index should be derived from fisheries independent surveys. Thus an international hydro-acoustic survey should be established to monitor trends in the horse mackerel age-structure and stock biomass across all national waters of the Black Sea.

The complete stock assessment results are presented in the Detailed Assessment (6.4).

Short and medium term scenarios:

Given the limitations, described above, with the Turkish CPUE used to tune the assessment, the EWG 14 14 did not undertake short or mdedium term predictions of stock size and biomass under various management scenarios.

The complete stock assessment projections are presented in the Detailed Assessment (6.4).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 14-14

E (1-4) = 0.4	None
B_{pa} (B_{lim}, spawning stock)=	None

Existing Management Measures

A partial description of management measures for horse mackerel is presented in the Detailed Assessment (6.4). A full description of national and international regulations for the horse mackerel fisheries will be completed during the next meeting Black Sea EWG meeting in 2015.

Comments on the assessment

Data and Information Gaps

EWG 14-14 recommends an international hydro-acoustic survey to monitor the horse mackerel across all national waters of the Black Sea. The time series currently in the assessment are very short and all efforts should be made to extend them backwards into the past when catches were much higher.

Progress since last Year in Addressing Gaps

Progress was made in improving the data quality and the assessment from previous year.

5.1.5 SUMMARY SHEET OF ANCHOVY IN GSA 29

Species common name: European Anchovy
Species scientific name *Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s): GSA 29

Available Fishery-Dependent Data

Of the six Black Sea countries, five are involved in the Black Sea anchovy fishery. As confirmed by the Ukrainian expert who participated in the EWG 14-14 meeting, the Russian Federation fleet exclusively targets Azov anchovy (*Engraulis encrasicolus maeoticus*), which is assumed to form an isolated stock; only negligible quantities of the Black Sea anchovy (*Engraulis encrasicolus ponticus*) exist in Russian waters. All the other countries exploiting Black Sea anchovy provided input to the assessment. The landings of Bulgaria, Georgia, Romania, Turkey and Ukraine; the age composition of the landings (except Georgia and Ukraine) and the mean weight at age in the landings (except Georgia and Ukraine) were made available to the assessment by the national experts. As the size of the anchovy exploited in 2013 remained within the minimum landing size limits (in contrast to the situation during 2011 and 2012 when large quantities of under-sized anchovy were discarded at sea), the discard rate were negligibly low and not reported by any of the countries. The maturity ogives and natural mortality estimates were assumed to be unchanged since the last assessment. In general, the catch of the anchovy increased markedly in 2012, in contrast to the decline in Ukraine.

The complete sets of compiled fishery-dependent data are presented in the Detailed Assessment (6.5).

Fisheries

The anchovy fleet is characterized by purse seiners usually coupled with a carrier boat. In some years when the sprat fishery is not profitable or anchovy schools are dispersed over wide areas, paired pelagic trawlers also take part in the anchovy fishery. Other gears, such as gillnet, coastal trap or pound nets, make negligible contributions to the total landings.

The largest fleet targeting Black Sea anchovy belongs to Turkey. In accordance with a bilateral agreement, since 2003, a small part of the Turkish purse seiners move to Georgian waters as soon as the Black Sea anchovy season is over on the Turkish coast. These boats are licensed to catch anchovy within the jurisdictional waters of Georgia and their catch is landed and registered at the Georgian ports.

Although only 10% of the fishing boats moved to Georgia in 2013 and took part in anchovy fishery the quantity of the fish landed in Georgia is almost half the Turkish anchovy landed in Turkey. Apparently the catch rates are much higher in Georgian waters. This is most probably a consequence of the different minimum size regulations applied between the countries.

The following table lists the landings (tons) by nation. The Detailed Assessment includes landings since 1967.

Year	Bulgaria	Georgia	Romania	Russian Federation*	Turkey	Ukraine	USSR*
1980	209				239289		165900
1981	70				259767		153272
1982	266				266523		175100
1983	784				289860		200630
1984	239				318917		240640
1985	92				273274		110200
1986	96				274740		191370
1987	13				295902		66241
1988	115	97452		64852	295000		
1989		32401		16426	96806		
1990		4656		6780	66409		
1991		5643		42	79225		
1992		6871		7294	155417	2572	
1993		1656		2137	218866	1598	
1994		857	197	4600	278667	242	
1995	35	1301	190	10071	373782	888	
1996	23	1232	140	2954	273239	596	
1997	44	2288	45	3283	213780	3623	
1998	48	2346	146	2465	195996	1039	
1999	36	1264	155	2268	310801	4872	
2000	64	1487	204	5292	260670	7719	
2001	102	941	186	7766	288616	5915	
2002	237	927	296	9271	336419	6739	
2003	131	2665	160	7999	266069	8868	
2004	88	2562	135	7323	306656	5687	
2005	14	2600	154	6706	119255	6200	
2006	6	9222	23	3925	212081	4907	
2007	60	17447	87	4900	357089	3363	
2008	28	25938	15	9500	225344	3761	
2009	42	31338	21	9927	185606	4653	
2010	65	39857	50		203026	5051	
2011	18	25919	41		205243	6932	
2012	7.4	55000	18		126331	6823	
2013	9.5	70700	111		153555	1686	

* Landings composed mostly of Azov anchovy (*Engraulis encrasicolus maeoticus*).

The complete sets of compiled fishery-dependent data are presented in the Detailed Assessment (6.5).

Available Fishery-Independent Data

Turkey is the only country currently conducting surveys targeting anchovy. One ichthyoplankton survey covering the entire extend of the Turkish EEZ and one hydroacoustic survey covering the overwintering ground was conducted in 2013. The results suggest that the age-0 anchovy distributed abnormally offshore were actually spawned within the southern half of the Black Sea.

The compiled fishery-independent data are presented in the Detailed Assessment (6.5)

Summary Maps

A series of maps representing i) spawning grounds of anchovy on the southern half of the Black; ii) overwintering concentrations; and iii) distribution of the fleet and the changes in their daily average catch are presented in section 6.5. The maps display year to year changes in the southern dispersal of spawning anchovy.

Fishing Effort

As may be expected for a small pelagic fish forming dense and large schools during the fishing season, a correlation analysis found no strong relationships between the catch of a purse seine boat per operation with its specifications, such as length, tonnage, length. Therefore it is assumed that the number of boats in the fleet is itself an indicator of the effort.

There has been a marked decrease in the fishing effort by the Turkish fishing fleet in the last decade. This is the consequence of the effort regulation measures recently enforced by Turkey, namely: (i) restricting anchovy fishing to night hours only (16:00 to 08:00) since 2007; (ii) setting a depth limit (0-24 m) for purse seining; and (iii) a vessel buy-back program launched in 2012 and repeated in 2013, in which more than 900 industrial class fishing vessel were removed from the fleet.

The compiled fishing effort data are presented in the Detailed Assessment (6.5).

Stock Assessment Summary

Two stock assessment methods (XSA and ASPIC) were applied to Black Sea anchovy. XSA was based on catch-at-age data for age classes 0 to 4+ from the period 1988 to 2013. However, a longer data series (1970-2013) were used in the ASPIC surplus production method. During these early years included in the ASPIC analysis the annual catch of Turkey was slightly higher compared to 2012,but still well below the average catch of the last 10 years. In constrast, Georgia raised the TAC in 2013 and the anchovy caught in the Georgian waters increased 2.1 times in 2011 and further increased by 1.3 times in 2013.

Most recent state of the stock

<u>State of the adult abundance and biomass (SSB):</u>

All model results show an increase in the spawning stock biomass in 2013 compared to 2012 and the degree of increase varies with the model settings for shrinkage.

<u>State of the juveniles (recruits):</u>

Recruitment during the last 25 years displays a cyclic pattern with peak values observed in 1994, 1999, 2006, 2012, which usually are followed by a drop. The pulse of a strong year class usually affects the next year’s SSB. This is the case during 2013; the strong recruitment in 2012 caused a rise in the number of spawners in 2013.

<u>State of exploitation:</u>

Estimated F is very much dependent on the level and type of shrinkage used in the XSA assessment. The general trend over the last ten years, however, indicates a slight decrease in the fishing mortality. The F values for 2012 and 2013 are much lower that the values estimated for 2010 and 2011.

<u>Source of data and methods:</u>

For the 2013 assessment the data set used in the 2012 assessment was updated with new data provided by the BS experts. The results of the hydroacoustic surveys conducted between 1980-2003 (with some missing years) by the former USSR and Ukraine were added as a tuning index; however its impact on the overall assessment was not significant.

In the ASPIC approach three different fleets and two different index datasets were used. The fleets are USSR operations in Georgian waters (1980-2013, with some missing years); Turkish boats fishing in the Georgian waters with a Georgian license; and the Turkish fleet. The index data were spawning stock biomass estimates and hydroacoustic estimates of overwintering biomass.

The complete stock assessment results are presented in the Detailed Assessment (6.5).

Outlook and management advice

<u>Short and medium term scenarios:</u>

The results of the analysis indicate that a very strong year class entered in 2012, which, as all assessment results agrees, increased the SSB in 2013. The F, however, which had been dropping noticeably, increased in 2013 but was much lower than in 2010 or 2011. The current exploitation rate (E=0.59) exceeds the precautionary threshold of 0.4 recommended for small pelagic fish. The high variability in the F estimates averaged over the last 5 years hampered our ability to make meaningful short term predictions.

The complete stock assessment projections are presented in the Detailed Assessment (6.5).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 14-14

E (mean)	$\leq$ 0.4

Table of limit and precautionary management reference points agreed by fisheries managers

F_{msy} (1-4)=	0.56
B_{pa} (B_{lim}, spawning stock)=	None

Existing management measures

The only country applying a catch quota to Black Sea anchovy is Georgia, where the quota increased from 60 000 to 80 000 tones in 2013. As no information is provided by the Georgian authorities concerning the methodology applied to estimate their TAC, it is not clear whether the increased quota is in line with the stock status. The lowest minimum landing size among the Black Sea nations is in Georgia (7 cm, TL). In the rest of the countries (Bulgaria, Romania, and Turkey) the minimum landing size is 9 cm of total length. In Turkey the anchovy fishery is restricted to night hours (16:00-08:00) and to winter months (15 Sep-Mar). As of 2011, purse seining is banned in the coastal zone in the bathymetric range of 0 to 24 m.

A complete description of management measures is presented in the Detailed Assessment (6.5).

Comments on the assessment

Data and Information Gaps

The catch at age and weight at age data are quite inconsistent over the years. This is most probably due to poorly harmonized age-length keys (ALKs). Not only do the ALKs differ from country to country, but there is also year to year inconsistencies within the national datasets. There is a great need to set up an agreed standard age reading protocol for the anchovy in the Black Sea. The inconsistency in the ALKs may also be due to fact that in some years Azov anchovy, which grow more slowly than BS anchovy and hence has different ALKs, expands its overwintering range and mixes with the Black Sea anchovy. None of the countries providing catch and weight at age to the assessment pays particular attention to existence of Azov anchovy in the catch and possible effects of mixing on the data.

The contribution of Georgia to the total anchovy landing has been increasing during the last years. The only information received from Georgia is the total landings. As Turkish boats licensed by the Georgian authorities, are the main exploiters of the anchovies in the Georgian waters several stock and effort variables are identical to those of anchovies fished in Turkish waters. In the assessment, the Georgian catch is simply added to the Turkish catch and the ALK prepared for Turkey is applied to the Georgian catch. However, the minimum allowable landing size in Turkey (TL=9 cm) is appreciably higher that in Georgia (TL=7 cm), with the consequence that the proportion of age-0 fish in the catch at age data is underestimated. Given that the Georgian catch is a significant and growing percentage of the total landings, it is crucial to know the exact length composition of the anchovy landed in Georgia.

Progress since last Year in addressing gaps

The effort data, which were available only for the Turkish purse seine fleet, have been expanded both for time and fleet coverage. The effort dataset is now available from 1970 to present. The purse seine boats operated in the Georgian waters were also included in the dataset.

The rate of zero year class anchovy discarded by the Turkish fishing fleet dropped remarkably in 2013 and the concerns raised during the previous report have been proven unimportant.

No progress was made concerning the harmonization of age readings; the ALKs are still questionable.

Only Turkey continues to conduct hydroacoustic surveys in the Black Sea. As the area covered by these surveys is restricted to the Turkish EEZ, the areas beyond, and particularly the Georgian waters, are still lacking survey coverage.

5.1.6 SUMMARY SHEET OF PIKED DOGFISH IN GSA 29

Species common name: Piked dogfish
Species scientific name *Squalus acanthias*
Geographical Sub-area(s) GSA(s): GSA 29

Available Fishery-Dependent Data

Data regarding landings at age, mean weight at age in the landings, maturity at age and natural mortality at age, growth parameters and mortality rates, maturity ogives at age including information for 2013, were provided to the EWG 14-14 only by Romania and Ukraine. Bulgaria only provided data on landings. The remaining riparian countries (Georgia, Russia and Turkey) provided no data.

Catch data for these three countries were estimated at the level of previous years. Estimates of the size compositions of the catches were provided only by Romania. Analysis of the length and weight classes of the piked dogfish caught during the period 2010-2013 showed the presence of medium-size individuals, with lengths ranging from 89 to 134 cm, but predominantly from 107 to 122 cm. In 2013, the predominant length ranged between 98 and 113 cm.

Fisheries

In the last 25 years, in the Black Sea the largest catches of piked dogfish have been from along the coast of Turkey, although this species was not the target of any fisheries, instead being caught as by-catch in trawl and purse seine operations, mainly during the winter. In the rest of the Black Sea countries most piked dogfish are harvested during spring and autumn months by target fishing that uses gill-nets of 100 mm mesh-size or that uses long-lines, and as by-catch in trawl fisheries for sprat.

During the 25 years for which landings data are available the largest annual catches of piked dogfish occurred during the early years of the series, with the peak landings of 6,159 t in the first year of the series (1989). Although the cumulative landings were taken primarily by Turkey and Ukraine, piked dogfish has lost its commercial importance in these countries. In the last three years, 2011-2013, about 40% of the landings were produced by Bulgaria.

Data for EU fisheries (Bulgaria and Romania) exploiting these stocks in 2013, in terms of fleets, fishing gears, deployed fishing effort (capacity in N°-GT-kW, activity in days at sea, gear characteristics), catches and catch composition, size composition, discards, fishing grounds and seasonality, were provided only by Romania. Most of the data were reported through the National Data Collection Programme and portions of the data were also uploaded into the JRC database.

In the report for this year Romania also provided information for 2011-2013 on changes in the number of gill net vessels by vessel length class. CPUE data are presented by fishing gear and vessel lengths for the last five years (2009-2013). Although the CPUE remained almost unchanged during this period, there was a decrease in the number of vessels operating the specialized fishing gear used for this species.

Table. of landings (t) by nation of piked dogfish from the Black Sea

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	TOTAL
1989	28	217	30	135	4558	1191	**6159**
1990	16	128	45	183	1059	1330	**2761**
1991	21	18	26	67	2017	775	**2924**
1992	15	14	52	15	2220	595	**2911**
1993	12	131	6	5	1055	409	**1618**

1994	12	45	2		11	2432	148	**2650**
1995	80	31	7		90	1562	67	**1837**
1996	64	71	5		19	1748	44	**1951**
1997	40	1	5		9	1510	20	**1585**
1998	28	550	5		6	855	38	**1482**
1999	25	18	5		9	1478	94	**1629**
2000	102	21	5		12	2390	71	**2601**
2001	126	27	5		27	576	134	**895**
2002	100	65	5		19	316	97	**602**
2003	51	40	5		29	184	172	**481**
2004	47	31	5		34	211	93	**421**
2005	15	35	5		19	102	75	**251**
2006	6	10	9		17	193	67	**302**
2007	24	2	17		32	91	45	**211**
2008	23	0	10		59	35	79	**206**
2009	9	2	4		14	159	47	**235**
2010	42	2	3		9	16	27	**98**
2011	38	2	4		4	27	31	**104**
2012	29	2	2		4	25	9	**70**
2013	31	2	9		4	25	13	**83**

The complete sets of compiled fishery-dependent data are presented in the Detailed Assessment (6.6).

Available Fishery-Independent Data

From Black Sea riparian countries, only Romania reported data on demersal trawl surveys for the period 2009-2013. In Romanian waters the swept area method was applied to estimate the biomass of piked dogfish. Results for estimated piked dogfish biomasses in May and November of 2009- 2013 in Romanian waters are given in the following tables with more detailed tables provided in the Detailed Assessment (6.6)

Species	**2009**	**2010**	**2011**	**2012**	**2013**
Piked dogfish	967-2,541	5,635-13,051	1,173-1,619	1,436-1,159	3,181-4,482

The calculated biomasses in the Romanian littoral zone ranged between 967 t and 13,051 t.

The compiled fishery-independent data are presented in the Detailed Assessment (6.6).

Summary Maps

For the EWG 14-14 only Romania prepared maps showing geographic density patterns and annual abundance indices derived from surveys and compare them with maps of geographical distribution patterns from previous years.

The Detailed Assessment (6.6) presents eight maps showing the seasonal distribution of piked dogfish agglomerations, and the abundance and biomass indices for the period 2009-2013.

Fishing Effort

The EWG 14-14 was not provided with quantitative information on fishing effort by all riparian countries. In 2011, 2012 and 2013 only Romania provided data regarding the number of gillnets by vessel length class. The number of vessels fishing gillnets for dogfish dropped from 265 in 2011 to 160 in 2012 and 25 in 2013.

The compiled fishing effort data are presented in the Detailed Assessment (6.6).

Stock Assessment Summary

The EWG 14-14 used the VIT4Win software for estimating abundance and fishing mortality of piked dogfish, and the program YPR-LEN (NOAA Fisheries Toolbox Version 3.1) for obtaining the reference points for dogfish in the Black Sea. Because results from these analyses depend heavily on uncertain assumptions, they should be viewed only as indicative of the possible status of piked dogfish in terms of exploitation.

An exploratory XSA was also conducted and considered to be indicative of trends for the SSB and to provide a qualitative estimate of F in comparison to F_{MSY}. The XSA model was tuned with the CPUE at age derived from the Romanian scientific demersal surveys during the last three years (2011-2013).

EWG 14-14 notes that piked dogfish are long-lived, late maturing, and have low fecundity, which means that the stock has very limited capability to rebound quickly once it becomes depleted. Further, the landings of piked dogfish have dropped steadily and dramatically since the start of the reported landings series, from more than 6,000 t in 1989 to only 80 t in 2013.

Most recent state of the stock

- <u>State of the adult abundance and biomass (SSB):</u>

Based on the XSA results as being indicative of trend, the SSB is estimated to be at the lowest observed level in the time series.

- <u>State of the juveniles (recruits):</u>

Based on the XSA results as indicative of trend, recruitment is estimated to be at the lowest observed level in the time series.

- <u>State of exploitation:</u>

Based on the VIT analysis, the fishing mortality rates during 2012 and 2013 were estimated to be 0.239 and 0.112 respectively. XSA estimates of current rates of fishing mortality are high (~0.3) and estimates of F for past years were erratic, exceeding 0.7 four times during 1999 to 2009. ICES estimated that F_{MSY} for piked dogfish in the North East Atlantic, expressed as the proportion of the total catches over the total biomass, is equal to 0.029, which corresponds approximately to an F of 0.03. Given (a) the uncertainty in the VIT and YPR-LEN analyses, linked to the assumption of constant recruitment, (b) the preliminary nature of the XSA analysis, and (c) the absence of more reliable information, the EWG considers it precautionary to use the F_{MSY} value estimated by ICES for piked dogfish in the North East Atlantic as an appropriate proxy for F_{MSY} for piked dogfish in the Black Sea.

In 2013, the F is estimated to be substantially larger than F_{MSY}. STECF EWG 14 14 classifies the stock of dogfish in the Black Sea as being exploited unsustainably and at the risk of collapse.

- <u>Source of data and methods:</u>

The catch-at-age matrices were based on length compositions and age/length keys from Ukrainian and Romanian samples. The VIT4Win software was applied to assess the population variables based on standard VPA and cohort analyses for data from 1989-2013. The final results were based on the analysis that assumed M = 0.15 and a terminal F of 0.15. The exploratory run with XSA was based on the same biological information used in the VIT and with landings at age tuned by CPUE at age derived from the Romanian scientific demersal surveys (2009-2013).

The complete stock assessment results are presented in the Detailed Assessment (6.6).

Outlook and management advice

Short and medium term scenarios:

Given the available data the EWG 14-14 was unable to make projections for the stock and estimate a TAC constraint for 2015. However, the EWG notes that the VIT and XSA analyses indicate that (a) fishing on this stock is far in excess of the F_{MSY} proxy, (2) the spawning biomass of piked dogfish has declined dramatically over the 25 years for which data are available and (3) the spawning biomass is estimated to be at its lowest observed level.

The complete stock assessment projections are presented in the Detailed Assessment (6.6).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 14-14

F 0.1 = (Fmsy proxy)	0.03 (from ICES 2014)

Table of limit and precautionary management reference points agreed by fisheries managers

F_{msy} (age range)=	None
B_{pa} (B_{lim}, spawning stock)=	None

Existing management measures

In the Black Sea area there are few management measures to protect the piked dogfish stock. For protecting the reproduction and rehabilitation of the piked dogfish stock, Romania adopted the following measures in its marine area:

- fishing for piked dogfish is prohibited for 60 days during April - June;
- use of trawl gear is banned in the marine zone depths less than 20 m;
- the mesh size for dogfish gillnets is 200 mm (stretched);
- the minimum admissible length in retained catches is 120 cm (TL)

In Ukraine, the mesh size for dogfish gillnets is 200 mm (stretched).
A complete description of management measures is presented in the Detailed Assessment (6.6).

Comments on the assessment

Data and Information Gaps

The following text remains fully relevant. It is from the 2012 report (EWG 12-15) and was quoted in the 2013 report (EWG 13-20).

The lack of a fishery independent scientific survey to monitor dogfish all over the Black Sea to indicate trends in total mortality and recruitment appears the major data deficiency in the assessment. EWG 12 15 recommends such a survey to be established. Also age reading of dogfish needs to be calibrated between different national laboratories to avoid discrepancy between national catch-at-age data.

Progress since last Year in Addressing Gaps

No progress has been made since last year.

5.1.7 SUMMARY SHEET OF RED MULLET IN GSA 29

Species common name: Red mullet
Species scientific name *Mullus barbatus*
Geographical Sub-area(s) GSA(s): GSA 29

Available Fishery-Dependent Data

Landings of Bulgaria and Romania are reported through the EU Data collection program. Landings data for Turkey and Russia were provided from the official national statistics. The catch at age matrix for the assessment was constructed based on landings data from all Black Sea countries except Ukraine as Ukraine is considered to exploit a different stock than other Black Sea countries. Age composition and weights of Turkish catches, (which account for 90% of the total catch on average) were used in the assessment.

Description of the Fisheries

Red mullet is one of the most important fish species fished and is consumed traditionally in Black Sea countries. In Turkey, it is mostly caught by bottom trawls as a target fish species. Red mullet is the second most frequently caught demersal species after whiting, composing 9.5% of total demersal catches between 1991 and 1996 (Genç, 2000). Fishing with gillnets is also allowed in the red mullet fishery all along the Turkish coast and through all seasons, but only 10% of total landing is obtained by this method.

Catches of red mullet in EU waters are taken primarily by Bulgaria (256.8 t during 2013, 30% of the Black Sea total), with only small amounts landed by Romanian fishers (2.5 t during 2013, about 0.3% of the Black Sea total).

In the waters of Georgia, according to the official statistics, there were no catches of red mullet during 1989 – 1996, or the catches were reported within the “other fish” group. During 1997 – 2005 the mean annual catch was 28 tons. According to Komakhidze et al. (2003), the red mullet was captured recently in higher amounts that provided indirect evidence of increasing abundance.

Along the coasts of the Russian Federation target fisheries for red mullet are performed mainly with passive fishing gears. The stocks exceeded 100 tons by 1998, which was mainly related to the reduction of the population of comb jelly (*Mnemiopsis leidyi*) (Volovik and Agapov, 2003). In 2002, the total biomass of red mullet was estimated to be 1200 tons, with an exploited biomass of 960 tons and TAC of 200 tons.

In Ukrainian waters, target fishing for red mullet was permitted only with beach seines and bottom set traps. However, the greater part of the catches corresponded to the non-target fishing with bottom traps (Shlyakhov and Charova, 2003). The major share of red mullet was harvested during autumn in Balaklava Bay, near Sebastopol. The amount of unreported catches of red mullet cannot be evaluated at present.

Table of red mullet landings (tons) in the Black Sea.

Years	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
1988				129		
1989				324		
1990				132		
1991				210		
1992				37		
1993				2		

1994				25		
1995				324		
1996				76	2249	
1997				68	1173	
1998				119	1423	
1999				92	1853	
2000	5.0			127	910	10.3
2001	26.0			119	1110	20.9
2002	33.0			47	867	40.7
2003	36.0			177	506	35.8
2004	17.0			99	668	23.0
2005	1.0			151	1093	17.5
2006	6.0			140	960	56.1
2007	12.5			87	781	54.4
2008	17.0			115	706	48.9
2009	48.2			291.7	799	65.2
2010	72.4			200.3	507	68.2
2011	176.2	22	1.9	290.9	326.1	58.2
2012	131.5		1.4	144.4	347.3	78.9
2013	256.8		2.5	180	318.2	92

The complete sets of compiled fishery-dependent data are presented in the Detailed Assessment (6.7).

Available Fishery-Independent Data

Age structured data (2009-2013 ages 1-5) from the Turkish Bottom Trawl Survey were used as a tuning index.

Maps of the biomass distribution from the survey in 2012 and 2013 are provided in the Detailed Assessment.

The compiled fishery-independent data are presented in the Detailed Assessment (6.7).

Summary Maps

Maps showing the spatial distribution of red mullet caught during 2012 and 2013 Turkish scientific surveys of the Samsun shelf area and western Black Sea are presented in the Detailed Assessment (6.7).

Fishing Effort

No information on fishing effort was presented at the EWG 14-14 meeting.

Stock Assessment Summary

A quantitative assessment of the red mullet stock in the Black Sea was conducted using XSA applied to a catch-at-age matrix for age-0 to age-6+ fish, over the period 1990 to 2013. During this period there was a general decline in the annual catches from about 2500 t to 700 t.

State of the adult abundance and biomass (SSB):

The SSB follows a consistent downward trend with periodic increases due to good recruitment (in 1994-1996 and 2004-2007). During the 1990s the SSB of the range of 5000 - 6000 t in the recent years it has dropped to about 1500-2000t. SSB in 2013 is estimated at 1173 t.

State of the juveniles (recruits):

Recruitment increased up to 2008 and since then started a decreasing trend. However, recruitment estimates are rather imprecise due to the lack of survey data. For catch forecasts recruitment is set equal to the geometric mean of the estimated recruitment values for 2010-2012.

State of exploitation:

Total catches have been gradually decreasing since 1996 under a consistently high fishing pressure due mainly to the Turkish fishery. Fishing mortality has been assessed as consistently high F= 0.8 - 1.4 since 1990, which is about 2-3 times the Fmsy of 0.46, F_{2013}=1.166 Under the status quo F scenario, catches are expected to remain low 733 - 680 t in 2014 - 2016, respectively. Under Fmsy fishing catches should drop to 331-419 t, which would results in some increase in SSB to 1360 t. At the present level of exploitation recruitment, that is only average in the last years, will not be sufficient to cause the SSB to recover.

Source of data and methods:

International landings data at age were constructed and the Extended Survivor Analysis (XSA) was applied. The short term predictions that are provided were based on assumed recruitment equal to the geometric average of recent recruitment.
The complete stock assessment results are presented in the Detailed Assessment (6.7).

Existing management measures

In Turkey the red mullet fishery is regulated by area and season closures, mesh size limitations, and minimum legal size limit. In Ukraine the fisheries regulations set the minimum commercial fishing size for red mullet, the allowable by-catch of juveniles in non-target fisheries, and the minimum mesh size in beach seines and in scrapers. In Bulgaria bottom-trawling is prohibited in Bulgarian waters and there is a closed season for all coastal fisheries.
A complete description of management measures is presented in the Detailed Assessment (6.7).

Short and medium term scenarios:

A short term prediction of stock size and catches, assuming a sustainable status quo fishing scenario, is provided together with a range of management options. Considering the short life span of red mullet in the Black Sea and the high variation in estimated recruitment, the EWG 14-14 emphasises that the short term projections are based on new the assumption of recruitment being equal to the geometric mean of recent recruitment and that the resulting catch advice is subject to high uncertainty. The poor knowledge about the recruitment dynamics prevented the formulation of medium term projections.

The complete stock assessment projections are presented in the Detailed Assessment (6.7).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-12

F0.1	≤ 0.46

Table of limit and precautionary management reference points agreed by fisheries managers

Fmsy (age range)=	none
Bpa (Blim. spawning stock)=	none

Comments on the assessment

Data and Information Gaps

The assessment assumes that red mullet in the Black Sea form a unit stock, but the scientific basis for this assumption has not been established. Genetic, morphometric and life-history studies on red mullet in the Black Sea are needed to identify possible stock boundaries.

More robust fishery sampling for age and size composition by all Black Sea nations is needed to provide better estimates of annual catch-at-age. In particular, given that catches and the importance of red mulled for the fishery of Bulgaria has been rising in recent years, this species needs to be sampled and submitted under the Data Collection Programme.

The current assessment only has a single tuning index (based on Turkish data) and trends in that index may not be representative of trends in other regions where the stock occurs and is fished. The Turkish sampling project is finishing in 2014, which will make it very problematic to use catch-at-age and tuning data from Turkey in the future.

Progress since last Year in Addressing Gaps

No new information to inform on the stock status has been presented.

5.1.8 SUMMARY SHEET OF ATLANTIC BONITO IN GSA 29

Species common name Atlantic Bonito
Species scientific name *Sarda sarda*
Geographical Sub-area(s) GSA(s): GSA 29

Available Fishery-Dependent Data

Data on landings of Atlantic bonito in the Black Sea are available primarily for Turkey. The other Black Sea nations, except for Bulgaria, have no reported landings for this species. No discard data for bonito are available. Length and weight data for bonito landed in Turkey were collected during the period 2000-2013, except for the years 2002-2004, from the Turkish border with Bulgarian to border with Georgia. In the available length frequency data almost all the fish were relatively small (<50 cm) and there were very few large mature individuals, which suggests that the adult portion of this population is unavailable to fishing operations in the Black Sea and may not reside in the Black Sea. However, reported Turkish landings of bonito are relatively low for the Aegean and Mediterranean Seas. Similarly, landings of bonito in Greece (Aegean Sea) are are relatively low, implying that neither the Aegean nor the Mediterranean Seas are the parental source for bonito in the Black Sea.

Description of the Fisheries

Fishing activity for bonito takes place in the Black Sea generally between September and November, and landings reach their highest levels during September in 2013. The vast majority of the bonito catches are by Turkish purse seine vessels (85%) and small fisheries vessels (15%).

The following table lists the landings (tons) by nation (in the seas of Turkey, Bulgarian and Greece).

Table 5.1.8.1. Fisheries statistics for countries

Year	Turkish Seas (Tons)					Country (Tons)		
	West Black Sea	East Black Sea	Marmara Sea	Aegean Sea	Mediterranean Sea	Turkey	Greece (Aegean Sea)	Bulgaria
1970	12486	596	2476	215	59	15832	-	30
1971	19935	900	2829	35	16	23716	-	41
1972	9246	846	1534	32	97	11755	-	0
1973	2269	939	327	73	45	3654	-	28
1974	3261	526	1338	91	72	5287	-	15
1975	2399	674	847	149	72	4140	-	0
1976	1555	829	363	207	72	3025	-	40
1977	1162	2332	664	78	104	4339	-	44
1978	1451	2629	1014	175	163	5431	-	11
1979	7294	782	283	82	198	8639	-	1
1980	11605	1882	939	151	333	14910	-	13
1981	6604	9733	7165	367	432	24300	-	0
1982	8629	11522	5262	432	133	25978	-	4
1983	8701	14668	5237	695	184	29485	-	24
1984	664	1938	4196	889	131	7818	-	1
1985	7486	3640	871	547	265	12809	-	1
1986	3422	5226	1572	675	531	11426	-	0
1987	5287	8026	2288	1018	714	17333	-	13
1988	5647	8186	1448	2178	674	18133	-	0
1989	1936	1936	592	219	325	5008	-	0
1990	4057	7199	2056	947	478	14737	927	17
1991	7030	9114	2037	1057	407	19645	793	15
1992	3399	2938	1028	920	578	8863	901	12
1993	4248	5213	8054	1419	614	19548	863	8
1994	2385	4492	1713	670	833	10093	1577	0
1995	861	6005	1125	508	445	8944	2041	25

1996	1285	5467	2502	534	496	10284	1744	33
1997	3362	2682	738	565	463	7810	1555	16
1998	12019	8461	2276	897	347	24000	985	51
1999	10775	4458	961	1303	403	17900	1167	20
2000	3084	6653	1248	692	322	11999	1002	35
2001	2905	5332	3345	1491	287	13360	1083	49
2002	2016	3159	479	350	282	6286	1315	0
2003	1924	3015	457	335	269	6000	1331	23
2004	1828	2685	434	318	256	5521	1294	18
2005	33572	30324	4878	1536	487	70797	1443	56
2006	19092	7373	2208	742	277	29692	994	8
2007	2707	1539	731	590	298	5865	1194	1
2008	2565	1971	1006	594	312	6448	1207	16
2009	2535	1681	983	754	1083	7036	981	5
2010	3408	2914	1304	809	966	9401	1240	16
2011	3555	3171	1054	1004	1235	10019	1222	8
2012	14991	14863	3008	2015	886	35763	-	96
2013	6671	3930	1180	732	645	13158	-	0

The compiled fishery-dependent data are presented in the Detailed Assessment (6.8).

Available Fishery-Independent Data

There are no fishery independent surveys for bonito in the Black Sea.

Summary Maps

No data are available to support the production of maps of the distribution of bonito.

Fishing Effort

The fleet profile of Turkish fishing fleet is published every year by TUIK. In 2013, there were 4879 vessels operating in the Black Sea of which 351 trawlers, 197 purse seiners, 89 transporter vessels and 4242 small-scale vessels. The numbers of purse seine vessel over 20 m length were 197 and targeted pelagic species like anchovy, horse mackerel, Atlantic bonito and blue fish during the fishing season of 2013, in the Black Sea. The number of purse seine vessels has varied annually in Turkey since 1984. There are no estimates of fishing effort for bonito except for 2012 and 2013.

The compiled fishing effort data are presented in the Detailed Assessment (6.8).

Stock Assessment Summary

The EWG was able to develop an exploratory assessment using the ASPIC biomass dynamics assessment software applied to landings data for bonito caught in the Marmara and Black Seas and corresponding fishing effort data measured in terms of the number of purse-seine vessels. However, it is unclear that the ASPIC biomass production model is capable of mimicking the cyclical stock dynamics that are evident in the landings data.

Information on the length frequency of the Turkish landings of bonito was assembled and growth curves were developed. The accuracy of the age determinations that underlie the growth curve estimates remains highly uncertain, particularly for the older fish, because of the scarcity of large fish.

Most recent state of the stock

Given the absence of any biological reference points for this stock or estimates of spawning stock biomass, the EWG 14-14 was unable to evaluate the stock status.

State of the juveniles (recruits)

The EWG was not able to estimate recruitment of bonito. However, the vast majority of the sampled catch consisted of young of the year fish, which implies that the catch is driven almost entirely by new recruitment. The spawning biomass that is the parental source of recruitment remains unknown.

State of exploitation

The EWG was unable to develop estimates of fishing mortality for bonito in the Black Sea.

Source of data and methods

All bonito samples were collected from market, purse seine and gill nets. Length, weight and sex was studied from 2000 to 2013 years. Landing data are published every year for all seas of Turkey by TUIK. The length frequency tables of these fish were analyzed to identify possible age modes and derive growth curves. Length-weight relationships were also derived. Further summaries and interpretations of the available data are presented in the Detailed Assessment (6.8).

Existing management measures

Atlantic bonito fisheries in Turkey are regulated by the Commercial Fishery Advice of General Directorate of Fishery. For purse seines, fishing is not allowed in waters shallower than 24 m (from the coastal). The depth of purse seine net must not be more than 164 m. Fishing period of purse seine is from 1 September to 15 April. Legal fish size is 25 cm for bonito.

Short and medium term scenarios

Although a 5-year projection for this stock was performed using the ASPIC software, the EWG did not cosider it to be sufficiently reliable to inform management decisions given the unusual cyclical dynamics apparent in the landings series.

Limit and precautionary management reference points

There are no limit and precautionary management reference points proposed by STECF EWG 14-14.

Table of limit and precautionary management reference points proposed by STECF EWG 14-14

Fmsy (1-3) proxy derived from F0.1	None

Table of limit and precautionary management reference points agreed by fisheries managers

Fmsy (age range)	None
Bpa (Blim, spawning stock)	None

Comments on the assessment

Data and Information Gaps

- Turkey should be encouraged to continue sampling its landings of bonito at a finer temporal scale (e.g., monthly) to provide a base of information that will clarify the growth of bonito and the relative strength of recruiting cohorts.
- Ichthyoplankton samples from oceanographic surveys should be explored for evidence that bonito spawns in the Black Sea and to identify spawning seasons and locations.
- An international survey is needed to monitor the distribution and abundance of bonito across all waters of the Black Sea, including the national waters of Bulgaria, Romania, Georgia, Russia, Turkey and Ukraine and Mediterranean countries.

Progress since last Year in Addressing Gaps

The 2012 EWG report identified the importance of Atlantic bonito and suggested that the available information be explored, with the aim of evaluating the potential for assessing this stock in the future. Although significant data gaps remain, the information compiled during EWG 14-14 and presented in the Detailed Assessment (6.8) is a significant improvement in the base of knowledge and information to support fishery management decisions regarding Atlantic bonito.

5.1.9 SUMMARY SHEET OF RAPA WHELK IN GSA 29

Species common name: Rapa whelk
Species scientific name *Rapana venosa*
Geographical Sub-area(s) GSA(s): 29

Available Fishery-Dependent Data

All the data were provided by experts from the Black Sea riparian countries. National data were provided by the statistical authorities of the countries and some corrections were made based on GFCM Statistics (in the case of 2011 and 2012 Romanian landings). There is lack of data on landings at age, discard at age, mean weight at age in landings and discards, due to difficulty of ageing this species in all countries, and with the landings time series for some countries. Though Ukrainian experts provided some data on age structures and age-length keys at the 2012 EWG meeting, it remains unclear that these data would be reliable if used as an age length key for rapana from other regions of the Black Sea.

This year, as in 2012, we prefer to focus on the length frequency data collected from landings of rapana. The main source is Turkish landings and there are no biological data from other nations other than total landings and number of vessels.

Fisheries

Rapa whelk has commercial, social and economic value in the region. Catch of Rapana started in Turkey in the mid-1980s and then became an important fishery resource for Ukraine, Bulgaria, and Georgia in the early 1990s. Much later beam trawls were permitted in Romania. Despite these positive fishery benefits, the *Rapana venosa* fishery is also the cause of a series of negative ecological impacts due to the use of beam trawls/dredges, which are harmful to the bottom habitat and the biodiversity due to high by-catch and discard rates.

At present dredging, beam trawling and diving are the basic methods used to harvest Rapa whelk in the region, but with different rates in the Black Sea nations. The share of the rapana catch by dredges and beam trawls is over 95% in Turkey, 95% in Bulgaria, 90% in Ukraine and 74% in Romania. Alternative fishing gears, such as pots/traps, are undergoing a trial period in Turkey in line with the importance of research for the EU to define the safest fishing techniques for demersal stocks, particularly for the veined Rapa whelk in the Black Sea.

It appears that Rapa whelk is in the position of 'a predator without enemy' thus exerting great pressure on natural marine filter-feeders like the blue mussel (*Mytilus galloprovincialis*) and striped venus clam (*Chamelea gallina*) and seriously endangering the ecological balance of the Black Sea.

Total production of Rapa whelk in 2013 reached 4819 t in Bulgaria, 1357 tons in Romania, 50 tons in Russia, 8655 tons in Turkey and 586 tons in Ukraine; summing up 15467 tons for the Black Sea total which is 12 % more than the 2012 production.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	TOTAL
1983					235		**235**
1984					122		**122**
1985					78		**78**
1986					2030		**2030**
1987					643		**643**
1988					7195		**7195**
1989					9239		**9239**
1990			75		6094		**6169**
1991			70		3738		**3808**

1992			110		3519	14	**3643**
1993			45		3668	3	**3716**
1994	3000				2607	5	**5612**
1995	3120	700			1198	303	**5321**
1996	3260	711			2447	376	**6794**
1997	4900	118			2021	476	**7515**
1998	4300	-			3998	369	**8667**
1999	3800	-			3588	619	**8007**
2000	3800	184			2140	913	**7037**
2001	3353	517			2614	395	**6879**
2002	698	503			6241	91	**7533**
2003	325	295			5500	149	**6269**
2004	2428	65			14034	159	**16686**
2005	511	70			12156	161	**12898**
2006	2773	300			10910	156	**14139**
2007	4310	-			13106	201	**17617**
2008	2872	-			11268	135	**14275**
2009	2214	-	2		6085	190	**8491**
2010	4381	-	0		5460	225	**10066**
2011	-	-	218		7770		**7988**
2012	3793		588		8893	509	**13783**
2013	**4819**		**1357**	**50**	**8655**	**586**	**15467**

The complete sets of compiled fishery-dependent data are presented in the Detailed Assessment (6.9).

Available Fishery-Independent Data

Majority of the data come from commercial fisheries except one survey conducted in 1992 in the Black Sea coasts of Turkey. Due to lack of finance or national data collection framework or no priority in the scientific interest, there are no comprehensive surveys in the countries or existing ones provide very limited information. Though there are several research studies carried out in Turkey but none of them have produced the data to cover the needs of any kind of assessments.

Most of the local surveys contain information on the shell length, total weight, body weight, length compositions, whelk weight per tow, sex ratio, without any age determinations. Also there is lack of fishing operational data covering enough areas to be considered representative of the population, which is distributed widely along the coast.

The compiled fishery-independent data are presented in the Detailed Assessment (6.9).

Summary Maps

N/A

Fishing Effort

Dredge or beam trawl vessels have overall length within 6-17 m. A single dredge is used in vessels smaller than 8 m and the larger ones generally use pair dredging. Actually, the use of pair dredges is prohibited by government regulations. But fishermen generally use them to obtain more catches and continue fishing also at night time, illegally. The number of vessels in the Samsun district, which is the main fishing port in Turkey, was 421 in 2005 and nearly half of them (232) had no licenses for Rapa whelk fishing. These vessels intensively operate in inshore benthic areas between depths of 5 and 33 m but mostly around 13 m. The compiled fishing effort data are presented in the Detailed Assessment (6.9).

Stock Assessment Summary
N/A

Most recent state of the stock

Although various research studies from different localities were done on several aspects such as the biology, population and ecology of Rapa, still little is known about this species and the present data lack any standard protocols for sampling, ageing, etc. We have no retrospective time-series data and the data provided already are not sufficient in quantity and quality for a stock assessment analysis. Furthermore, there is no current study on Rapa that considers the parameters required for conducting a stock assessment that would cover all the Black Sea countries. If there are plans to conduct a stock assessment, the first step has to be the development of a standardized method for data collection and compilation.

At present we have only some data on population parameters, growth and mortality based on indirect ageing methods, landings at length, meat yield and feeding.

The future work flow for Rapa whelk was discussed in the Black Sea EWG and it was concluded to monitor Rapa with a series of case studies at least for now and to encourage countries to plan surveys in order to collect new data with a standard methodology required for applying proper stock assessment.

The complete stock assessment results are presented in the Detailed Assessment (6.9).

Outlook and management advice

Short and medium term scenarios:
N/A

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 14-14

N/A	

Table of limit and precautionary management reference points agreed by fisheries managers

F_{msy} (age range)=	N/A
B_{pa} (B_{lim}, spawning stock)=	N/A

Though Rapana is in the priority list of stocks being considered by the STECF EWG, there needs to be agreements on the target for management of the Rapa stock. The EWG does not consider F_{MSY} to be an appropriate target given that rapana is an invasive predatory species that has had a negative impact on other native Black Sea species. The impact of rapana on its prey is very important to document and monitor. Black Sea nations need better monitoring of the rapana stock, including the prey-predator relationships, and they need to create common indices to monitor the distribution trend and pattern of Rapa whelk (as CPUE, mapping) in the region.

Existing management measures

In all of the countries, dredging and beam trawling is allowed, but in different size and shapes. In Ukraine, an annual limit for sea snail harvesting up to 400 t has been in effect since 2002. There are no quotas in other countries but there certain management measures are applied. Licensed scuba diving is also permitted to harvest Rapana.

In Turkey, management measures can be summarized as follows: minimum mesh size in the codend of dredges (3m x 0.4 m frame) is 40 mm and maximum codend is 1 m in length; scuba diving was allowed throughout the year but dredges are banned between 1 May and 30 August; dredging at night is not allowed in the fishing season and within the 500 m distance from the shore.

In Bulgaria the use of all kinds of active fishing gear including bottom gears is completely prohibited; beam trawling is allowed since 2012.

Ukraine has a 400 tons TAC, reduced each year.

Romania has only 7 dredge vessels operating in coastal waters but has officially declared for 2013 a large effort of Beam trawlers (TBB) being 50% of total national fishing effort. It appears that TBB exlusively traget Rapana.

A complete description of management measures is presented in the Detailed Assessment (6.9).

Comments on the assessment

Data and Information gaps

- Lack of ageing method,
- Less priority within the supported national scientific survey program,
- Lack of proper monitoring,
- No financial support in local or regional level

Progress since last year in addressing gaps

No further progress other than to academic interest.

6. DETAILED ASSESSMENTS

6.1 SPRAT IN GSA 29

6.1.1 Biological features

6.1.1.1 Stock identification

The Black Sea sprat (*Sprattus sprattus L.*) is a key species in the Black Sea ecosystem. Sprat is a marine pelagic schooling species sometimes entering in the estuaries (especially as juveniles) and the Azov Sea and tolerating salinities as low as 4‰. In the daytime it keeps to deeper water and at night moves near the surface. It forms big schools and undertakes seasonal movements between foraging (inshore) and spawning (open sea) areas (Ivanov and Beverton 1985). Adults tend to remain under the seasonal thermocline. Penetrating above occurs only during the spring and autumn homothermia. Juveniles are distributed in a larger area near the surface. Sexual maturity is attained at the age of 1 year and length of 7 cm. In Turkey it was found that males reached maturity at 7.5 cm and females at 7.8 cm at age 1 (Avşar & Bingel 1994). Sprat is one of the most important fish species being fished and consumed traditionally in the Black Sea countries. It is the most abundant small pelagic fish species in the region together with anchovy and horse mackerel and accounts for most of the landings in the north-western part of the Black Sea. Whiting is also taken as a by-catch in the sprat fishery although there is no targeted fishery beyond this (Raykov 2006) except for Turkish waters. Sprat fishing takes place on the continental shelf between 15-110 m of depth (Shlyakhov and Shlyakhova. 2011). The harvesting of the Black Sea sprat is conducted during the day time when its aggregations become denser and are successfully fished with trawls. The main fishing gears are mid-water otter trawl pelagic pair trawls and uncovered pound nets.

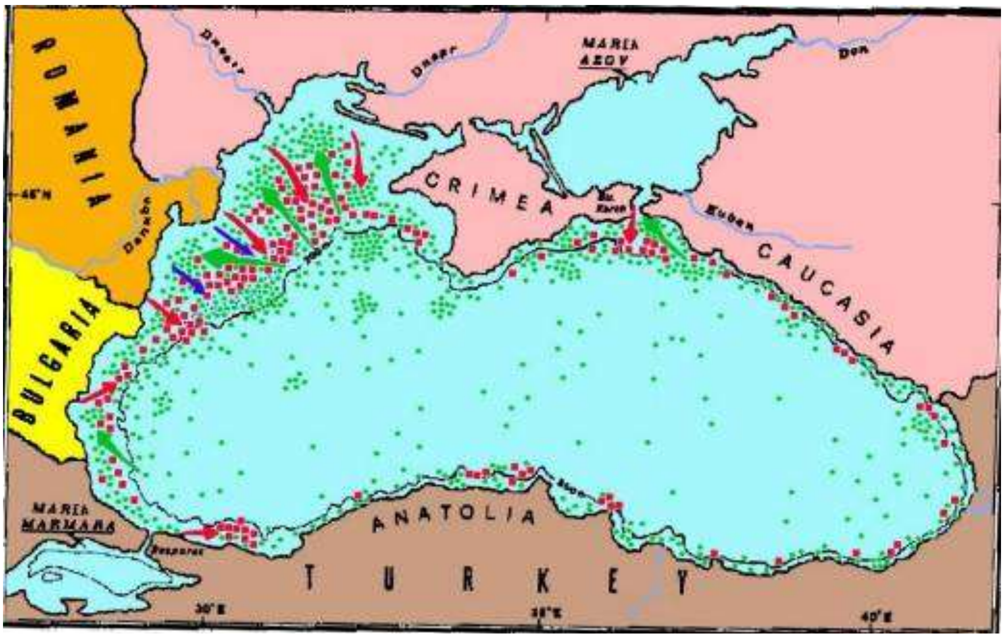

Fig. 6.1.1.1.1 Sprat distribution and migration in the Black Sea

Legend:

Wintering areas and migration to

Spawning areas and migration to them

Feeding areas and migration to them

6.1.1.2 Stock structure assumed in the Assessment

The sprat has a unit stock in the level of Black Sea. The data for assessment were provided by all Black Sea countries with the exception of Georgia.

6.1.1.3 Growth

The species is fast growing; age comprises 4-5 age groups. The von Bertlanffy Growth Parameters VBGF by countries for 2013 is given in Table 6.1.1.3.1. In Romanian waters asymptotic length and growth rate is comparable with the growth parameters derived in Bulgarian and Ukrainian Black Sea waters (Table 6.1.1.3.1). In Turkish waters the asymptotic length significantly differs for 2013.

Table 6.1.1.3.1. VBGF parameters calculated in the Black Sea for 2013.

	L∞	k	t0	a	B
Bulgaria	12.03	0.66	-1.33	0.008	2.784
Romania	12.10	0.35	-1.67	0.0064	2.974
Ukraine	12.42	0.286	-1.504	0.0085	2.969
Turkey	13.04	0.445	-1.096	0.004	1.878

The three modal distributions of lengths from commercial sampling were recorded, as the highest percentage belong to the class of 8 cm. The length from 9.5 to 11 cm have subdominant role (Fig. 6.1.1.3.1.).

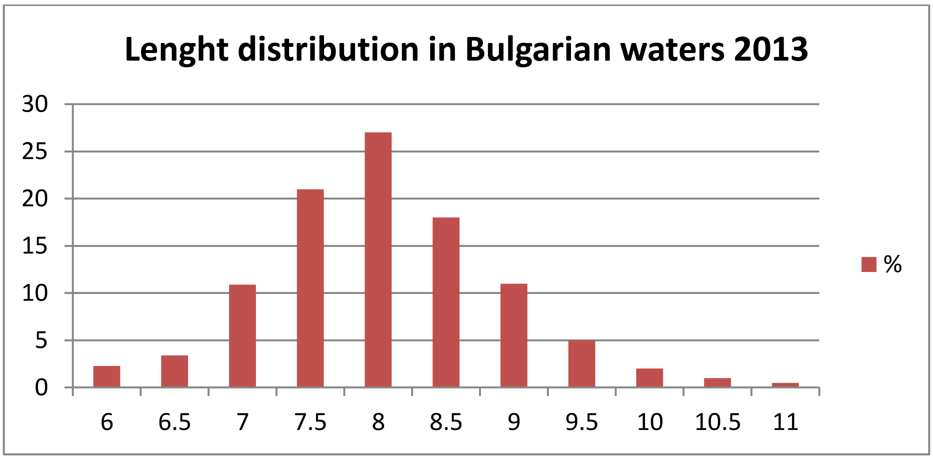

Fig. 6.1.1.3.1. Length distribution of sprat from commercial catches in Bulgarian waters, 2013

The maximum age was reported as 5 years within a variety of studies carried out in Samsun Shelf Region and in other sub regions of the Black Sea basin (Figure 6.1.1.3.2.). The sprat has a high recovery rate with strong recruitments (Avsar and Bingel, 1994; Prodanov et al., 1997). In the sampling studies with the commercial vessels in Samsun Shelf Region, in 2013, it was observed that a large extent of landings (86.3%) were of 1 and 2 age groups that attained sexual maturity. Age 3 was represented by 12.3% of the sampling and age 4 and 5 by 6% and 0.5%, respectively.

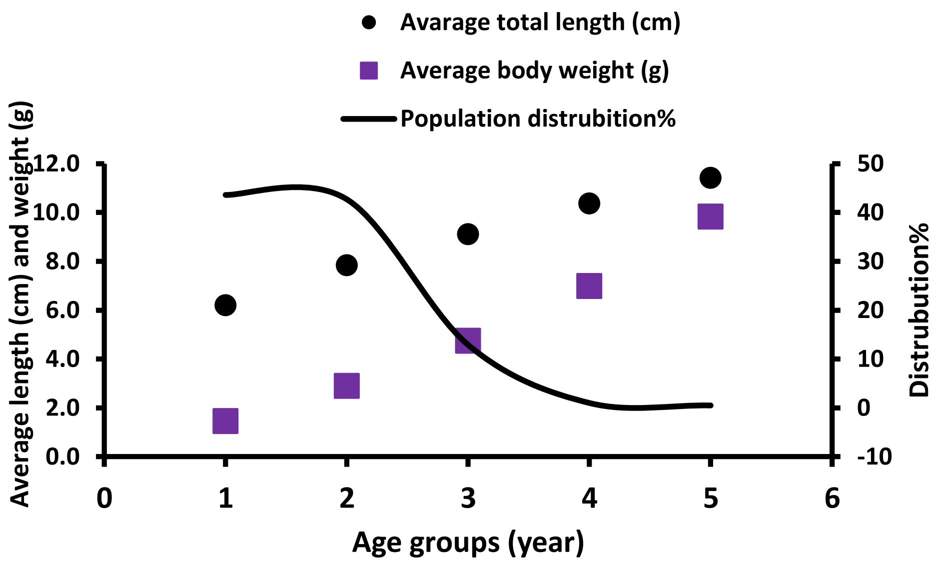

Figure 6.1.1.3.2. Age groups and average length and weight distribution of Sprattus sprattus in the Samsun Shelf Area in 2013.

The length and weight frequency distributions were presented in Figures 6.1.1.3.3. and 6.1.1.3.4. The mean length and body weight is found respectively 7.74 (4.5-12.17) cm, and 3.08 (0.10-12.98) g. The age range was determined as 1-5 years. The von Bertalanffy growth parameters were estimated as L∞ = 13.09 cm, K=0.477 year^{-1} and t0= -1.199 year and the constant and slope in length-weight relationship were calculated as 0.004 and 3.29 (Rsq= 0.92) respectively, for whole sub sampling (n=3819) periods in 2013 (Figure 6.1.1.3.5.).

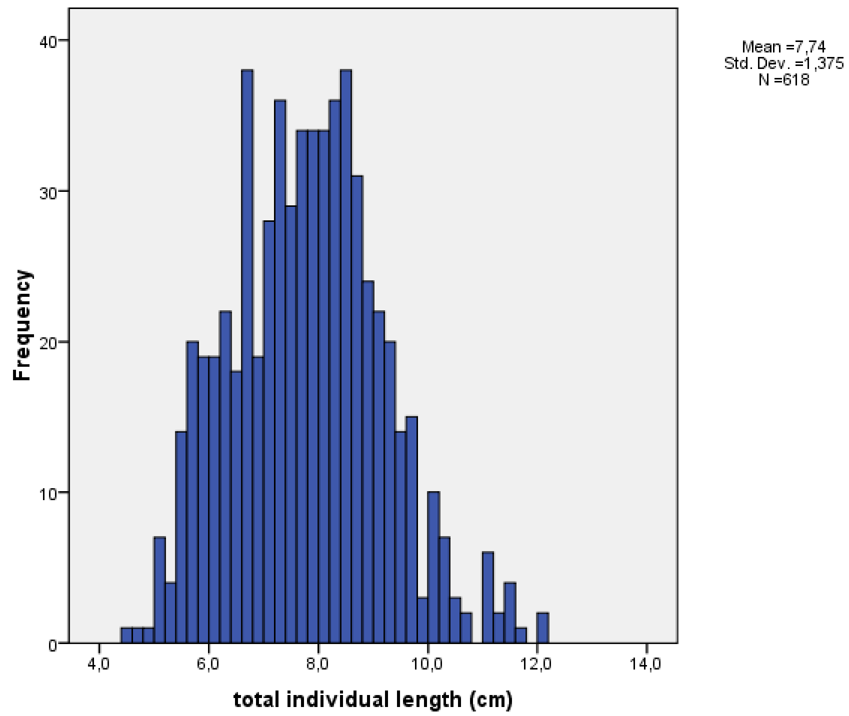

Figure 6.1.1.3.3. Length frequencies of sprat from Turkish waters in 2013.

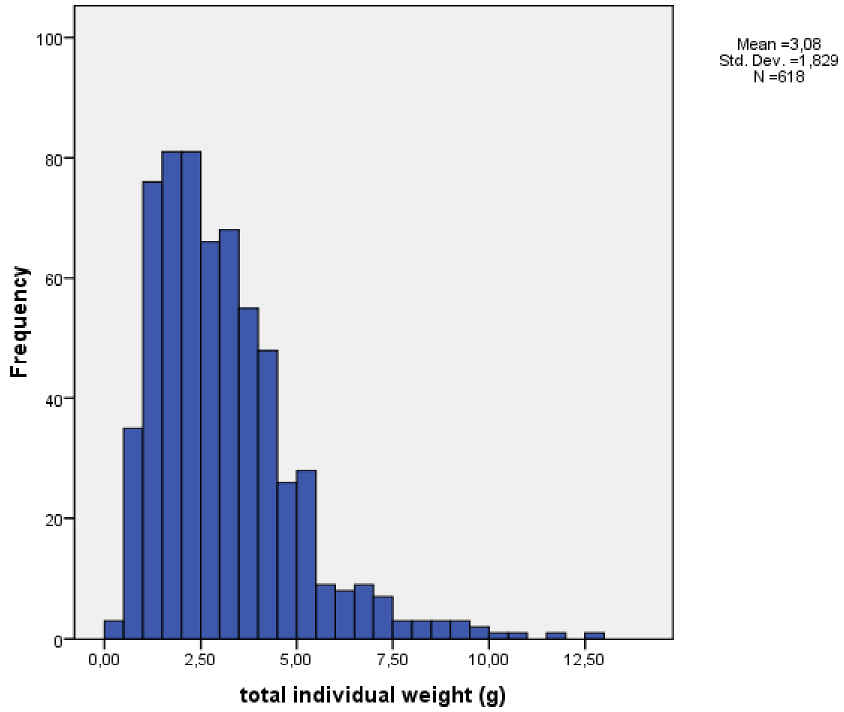

Figure 6.1.1.3.4. Length and weight frequency distributions of sprat for spring 2013 from Samsun shelf area.

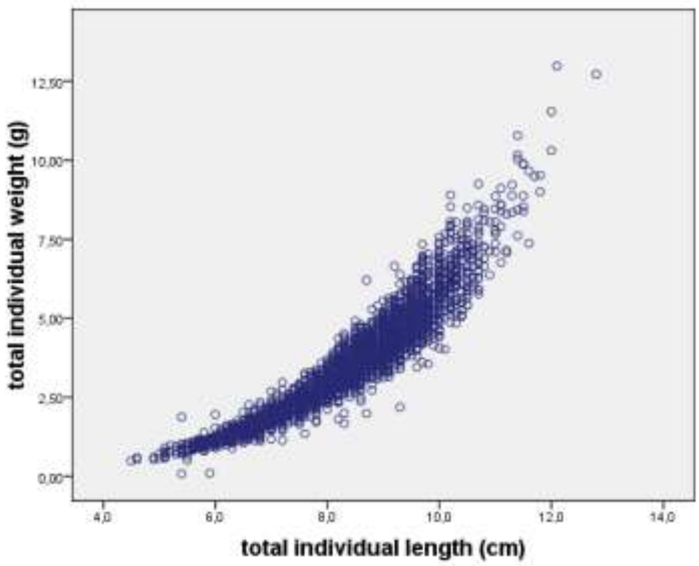

Figure 6.1.1.3.5. Length-weight relationship of sprat population in 2013

6.1.1.4 Maturity

No maturity studies were conducted in 2013

6.1.2 Fisheries

6.1.2.1 General Description

The sprat fishery is taking place in the Black Sea (GFCM Fishing Sub-area 37.4 (Division 37.4.2) and Geographical Sub-area (GSA) 29). The opportunities of marine fishing are limited by the specific characteristics of the Black Sea. The exploitation of the fish resourses is limited to the shelf area. The water below 100-150 m is anoxic and contains hydrogen sulphide. In Bulgarian, Romanian, Russian and Ukrainian waters the most intensive fisheries of Black Sea sprat is conducted from April till October with mid-water trawls on vessels of 15- 40 m length and a small number of vessels > 40m. Beyond the 12-mile zone a special permission is needed for fishing. Harvesting of Black Sea sprat is conducted during the day when the sprat aggregations become denser and are successfully fished with mid-water trawls (Shlyakhov and Shlyakhova 2011; Shlyakhov *et al*., 2012; Kumantsov and Raykov 2012). The use of paired vessels in pelagic trawling along Yesilirmak - Kizilirmak shelf area in southern Black Sea gained importance by 1990s and became wide spread by 2000s. At present nearly 40 pairs of vessels are operating along the mentioned area. The total catch of sprat -as a target species- is directly transported to fish meal and oil fabrics as raw material (Knudsen and Zengin 2006).

The significance of the sprat fishery in Turkey in the last three years has increased and the landings reached 87 141 t in 2011. In 2012 drastic decrease down to 12 092 thas been observed. In contrast the catches in 2010 was 57 023 t which is close to the 5 years average value of the Turkish sprat catches in the Black Sea. In the 2013 the total sprat landings decreased by 9018 tons in comparison with 2012. The Turkish landings accounted 9677.4 t in 2013, which represents substantial drop down in comparison with Turkish catch in 2011 (77463 tons less in 2013). The main gears used for sprat fishery in Turkey (fishing area is constrained in front of the city of Samsun) are pelagic pair trawls working in spring at 20 - 40m depth and in autumn - in deeper water: 40-80m depths. At the same time the Turkish pair-trawl fishermen used the same gear targeting horse mackerel and anchovy in the same area.

6.1.2.2 Management regulations applicable in 2012 and 2013

A quota (Table 6.1.2.2.1) is allocated in EU waters of the Black Sea (Bulgaria and Romania). No fishery management agreement exists among other Black Sea countries. In the EU Black Sea waters a global (both Romania and Bulgaria) TAC of 12 750 tons has been allocated in 2009 and 2010. In 2011 and in 2012 and 2013 allocated quota in Bulgarian waters was at the rate of 8 032.5 t (Council Regulation 5/2012) and 3 442.49 t for Romanian waters .The decreasing trend in indices since 2008 was observed despite of quotas regime in force in community waters. Because of insufficient national funding by NDCP, the hydro acoustic survey (2012 and 2013) for the assessment of sprat stocks in front of Bulgarian Black Sea coast was not carried out. In 2013 hydro acoustic survey in summer was conducted in the Turkish Black Sea waters. From the catches of fish only the turbot species (*Psetta maxima*) and sprat (*Sprattus sprattus*) are subject to quotas and are included in the National data collection program (NDCP). The applied quotas are precautionary because it is not possible to calculate the whole biomass for the whole water basin of the Black Sea.

Table 6.1.2.2.1. EC quota and recommended Total allowable catch of sprat in EU waters for 2008-2013.

Year / National data	2008	2009	2010	2011	2012	2013
Spicies	***Sprat (SPR)***	***Sprat (SPR)***	***Sprat (SPR)***	***Sprat (SPR)***	***Sprat (SPR)***	***Sprat (SPR)***
Quota. t	15 000[2]	12 750[2]	12 750[2]	11 475[2] 8032.51	11 475[2] 8032.51	11 475[2] 8032.51
Total catch. t	4 300.0363(BG) 234 (RO)	4 541.35 (BG) 92(RO)	4 039. 966 (BG) 39(RO)	3 957.895 (BG) 131.3 (RO)	3 156.832 (BG) 87.458(RO)	3784.191 (BG) 98.84(RO)
Biomass. t	32 718.33 60 000[5]	41 761.398[3] 60 000[5]	75 080.20[4] 59 600[5]	48 201.7[4] -	- 688 865	- 56 428
Recommended TAC	average 13 746.57	11 469.9[3]	12 500[4]	-	-	-

NB: 1 - quota according to Regulation (EU) № 1579/2007. Regulation (EU) № 1139/2008. Regulation (EU) № 1287/2009. Regulation (EU) № 1004/2010. Regulation (EU) № 1256/2010. Regulation (EU) № 5/2012
2 - EC's quota
3 - Source of data: Institute of Oceanology – BAS. Bulgaria
4 - Source of data: Institute of Oceanology – BAS. Bulgaria and NIMRD,Romania
5National Institute for Marine Research and Development. Romania

Sprat fishery in Turkey was firstly promoted by the Commercial Fishery Advice of General Directorate of Fishery with date of 02.08.2002 and number of 24 834 regarding the years 2002-2004 (Section 2. Article 5) (Anonymous 2002). New management criteria were brought into force for sprat fishery. These criteria were summed up in four topics as:

Regulations about fishing area: Sprat fishery by pelagic trawls should be conducted only along Samsun shelf area. The coordinates of this area were specified. But except sprat the fishery was allowed for anchovy horse mackerel and bluefish along other trawling areas in Black Sea.

Regulations about fishing gear: In Turkey pelagic trawls operate as paired vessels. Vessels engaged in sprat fishery need to receive licence eligible only for one fishing period from Samsun City Directorate of Food. Agriculture and Livestock. The single vessel operation in pelagic fishery seems to be inconvenient for Turkey at least for now as the fisherman can quickly change the gear to bottom trawling during operation.

Regulations about time periods: Though pelagic fishing period starts in 15 September as same as bottom trawling, it lasts to 15 May. Bottom trawling ends by 15 of April. There is no limitation in distance from land for pelagic trawling.

Regulations about depth: The pelagic fishery is banned in waters shallower than 18 m between 15 September and 15 April. But between 15 April-15 May it is allowed in waters deeper than 36 m limited with offshore of Çayağzı Cape (Samsun-Yakakent) in west and Akçay estuary (Samsun - Ordu city border) in east (Anonymous. 2006). Sprat catch reaches a maximum in this one month-period and provide a great economic input for fishermen. Conversely bottom trawling limitations include distance from land. But as mentioned above the depth limitation is increased to 36 m by 15 April in order to protect spawning adults and juveniles on coastal zone.

Table 6.1.2.2.2.Sprat TAC applied in Ukraine and Russian Federation in tons.

Year	Russian Federation	Ukraine
2005	42 000	60 000
2006		70 000
2007		40 000
2008	21 000	50 000
2009	21 000	50 000
2010	21 000	50 000
2011		60 000
2012		70 000
2013		70 000

Table 6.1.2.2.3. Minimum landing size of sprat in the Black sea region

	BG	GE	RO	RU	TR	UA
Sprattus sparttus	TL=7cm	SL=6cm	TL=7cm	SL= 6cm	NO	SL=6cm

Legend: TL-total length; SL-standard length;

6.1.2.3 Catches

6.1.2.3.1 Landings

Catch and landings of the sprat in the Black Sea were reported by the Black Sea countries and data from Bulgaria and Romania were collected and reported for the Data Collection Program from National agencies for fisheries and aquaculture in both countries. Mid-water trawl (OTM) catches dominate the landings. Landings significantly decreased in 2013 in Turkey from 12091.7 t (2012) to 9677.4 t (2013) but also a gradual decrease is reported by Russian Federation and Ukraine). Romanian catches decreased to 98.84 tons in 2013 (Table 6.1.2.3.1.1).

Table 6.1.2.3.1.1. Sprat landings in the Black Sea.

year	Bulgaria	*Bulgaria	Romania	Ukraine	Turkey	Georgia	Russian Federation	Total
1970	1407		2678	353	0	0		4438
1971	2473		2517	846	0	0		5836
1972	2962		23	884	0	0	16	3885
1973	3383		22	878	0	0	22	4305
1974	4468		1245	477	0	0	23	6213
1975	5565		731	787	0	0	43	7126

1976	7199		161	1594	0	0	16	8970
1977	8754		1463	4346	0	0	2354	16917
1978	10596		149	1949	0	1	3317	16012
1979	13541		2269	36757	0	3466	17700	73733
1980	16568		989	47635	0	4571	14687	84450
1981	1888		2283	49175	0	5781	20165	79292
1982	16524		3004	3862	0	2462	15266	41118
1983	12023		3406	20755	0	886	3843	40913
1984	13921		4456	18021	0	847	5270	42515
1985	15924		6836	23657	0	1817	3365	51599
1986	1169		8979	33147	0	2939	7010	53244
1987	10979		9474	43158	0	697	8972	73280
1988	6199		6454	39835	0	7172	7157	66817
1989	7403		8911	63239	0	9708	16045	105306
1990	2651		3198	33174	0	6895	6955	52873
1991	1909		729	11094	0	2313	2675	17082
1992	2353	3266	2074	11492	0	830	3221	20883
1993	2174	3705	2439	9154	640	32	694	16664
1994	2200	3499.943	2203	12615	700	308	1013	20338.94
1995	2874	3199.948	1982	15218	157	288	1263	22107.95
1996	3535	3499.943	2014	20720	937	185	1537	28892.94
1997	3646	3645.94	3318	20208	468	85	706	28430.94
1998	3275	3274.946	3293	30282	1236	24	1243	39352.95
1999	3595	3594.941	1933	29238	421	45	4473	39704.94
2000	1737	3499.943	1803	32644	6225	42	5543	49756.94
2001	695	6961.121	1792	48938	1008	40	11122	69861.12
2002	11595	11595	1617	45430	1965	34	11218	71859
2003	9155	9154.6	1219	31366	5775	2	204	47720.6
2004	2889	7996.9	135	30891	5186	12	143	44363.9
2005	2575	6500	1487	35707	5271	19	1316	50300
2006	2655	8183.153	492	21308	6681		8157	44821.15
2007	2559	2984.59	208	18013	11725		6077	39007.59
2008	4304	4304	234	21111	39903		7814	73366
2009	4551	4551	92	24603	53385		8744	91375.48
2010	4041	4041	39	24652	57023		5839	91594
2011	3958	3958	131	24379	87141		5099	120707.8
2012	3157		88	15751	12092		3937	35024.86
2013	3784.191		98.84		12866.05	9677.4	842	27268.48

*expert assessment

EWG 14-14 notes that the landings listed, for EC countries, are largely consistent with the quantities submitted to JRC through the DCF 2013 Med and Black Sea data call.

6.1.2.3.2 Discards

No discards of sprat have been reported with the exception of Romanian reports giving figures of sprat discards. Such discards are very low but increasing and accounted 38 tons in Romanian waters in 2013.

6.1.2.4 Fishing effort

Table 6.1.2.4.1. DCF fishing effort (number of vessels) as submitted to JRC through the DCF 2013 Med and Black Sea data call by major gear type 2008-2013 in Bulgaria (A) and Romania (B)

(A)

YEAR	VESSEL_LENGTH	GEAR	MESH_SIZE_RANGE	FISHERY	AREA	NOMINAL_EFFORT	GT_DAYS_AT_SEA	NO_VESSELS
2008	VL1824	OTM	14D16	MDPSP	SA 29	16560	5100	2
2008	VL1218	OTM	14D16	MDPSP	SA 29	2740	304	4
2008	VL0612	FPN	14D16	MDPSP	SA 29	72575	32256	13
2008	VL0006	FPN	14D16	MDPSP	SA 29	3198	410	4
2009	VL2440	OTM	14D16	SPF	SA 29	10592	4352	2
2009	VL0612	FPN	14D16	MDPSP	SA 29	113342	50377	17
2009	VL0006	FPN	14D16	MDPSP	SA 29	5429	714	7
2010	VL2440	OTM	14D16	SPF	SA 29	662	272	1
2010	VL0612	FPN	14D16	MDPSP	SA 29	102528	45546	14
2010	VL0006	FPN	14D16	MDPSP	SA 29	2624	100	3
2011	VL2440	OTM	14D16	SPF	SA 29	27158	8012	2
2011	VL2440	OTM	14D16	MDPSP	SA 29	4416	1290	1
2011	VL0612	FPN	14D16	MDPSP	SA 29	90236	26371	40
2011	VL0006	FPN	14D16	MDPSP	SA 29	1727	151	8
2012	VL2440	OTM	14D16	SPF	SA 29	23405	6837	1
2012	VL1218	FPN	14D16	DEMSP	SA 29	695	68	1
2012	VL0612	FPN	14D16	DEMSP	SA 29	195992	52100	27
2012	VL0006	FPN	14D16	DEMSP	SA 29	2394	199	4
2013	VL2440	OTM	14D16	SPF	SA 29	52245	11280	2
2013	VL1218	OTM	14D16	SPF	SA 29	3530	384	1
2013	VL0612	FPN	14D16	MDPSP	SA 29	195548	38434	22
2013	VL0612	OTM	14D16	SPF	SA 29	528	37	1
2013	VL0006	FPN	14D16	MDPSP	SA 29	3270	431	4

(B)

Year	Vessel Length	Gear	Mesh Size Range	Fishery	Area	Nominal Effort	GT_Days_at_Sea	Num Vessels
2008	VL0006	SB	00D14	MDPSP	SA 29	86279	7201	45
2008	VL0612	FPO	00D14	MDPSP	SA 29	16388855	155008	192
2008	VL1218	OTM	00D14	SPF	SA 29	1068620	146035	9
2008	VL1824	OTM	00D14	SPF	SA 29	808959	204422	4
2008	VL2440	OTM	20D40	SPF	SA 29	4251250	2025889	11
2009	VL0006	SB	00D14	MDPSP	SA 29	35948	6960	38
2009	VL0612	FPO	00D14	MDPSP	SA 29	12075037	1178437	169
2009	VL1218	OTM	00D14	SPF	SA 29	2957668	434558	15
2009	VL1824	OTM	00D14	SPF	SA 29	1440379	376387	5
2009	VL2440	OTM	20D40	SPF	SA 29	5520149	2650975	12
2010	VL0006	SB	00D14	MDPSP	SA 29	249121	27299	64
2010	VL0612	FPO	00D14	MDPSP	SA 29	18617358	1710535	188
2010	VL1218	OTM	00D14	SPF	SA 29	3559407	449947	6
2010	VL1824	OTM	00D14	SPF	SA 29	1306384	351630	7
2010	VL2440	OTM	20D40	SPF	SA 29	6995010	3003786	13
2011	VL0006	SB	00D14	MDPSP	SA 29	34136	3493	39
2011	VL0612	FPO	00D14	MDPSP	SA 29	740804	64139	87
2011	VL0612	OTM	00D14	MDPSP	SA 29	180869	15660	4
2011	VL1218	OTM	00D14	SPF	SA 29	5833424	827010	23
2011	VL1824	OTM	00D14	MDPSP	SA 29	856319	246060	5
2011	VL2440	OTM	20D40	SPF	SA 29	6172300	2718507	11
2012	VL0006	SB	00D14	MDPSP	SA 29	1649473	156317	124
2012	VL0612	FPO	00D14	MDPSP	SA 29	4694659	389268	104
2012	VL0612	OTM	00D14	MDPSP	SA 29	26822	2224	8
2012	VL1218	OTM	00D14	SPF	SA 29	7499190	1001555	26
2012	VL1824	OTM	00D14	MDPSP	SA 29	2080654	543064	12
2012	VL2440	OTM	20D40	SPF	SA 29	5570111	2511970	10
2013	VL0006	FPO	00D14	SPF	SA 29	295.47	54.27	1
2013	VL0612	FPO	00D14	SPF	SA 29	22012.69	2297.76	31
2013	VL0612	OTM	00D14	MDPSP	SA 29	10819.3	1204.68	10
2013	VL1218	OTM	00D14	MDPSP	SA 29	193288.8	22383.5	35
2013	VL1824	OTM	00D14	MDPSP	SA 29	135303.2	38066.1	13
2013	VL2440	OTM	20D40	MDPSP	SA 29	430653.6	207801	11

6.1.2.5 Commercial CPUE

Commercial CPUE $kg.h^{-1}$ has decreased in Bulgarian and Ukrainian waters in the 2010-2013. The same trend is detected for the 2010-2013 in Turkey sprat fishery (Figure 6.1.2.5.1).

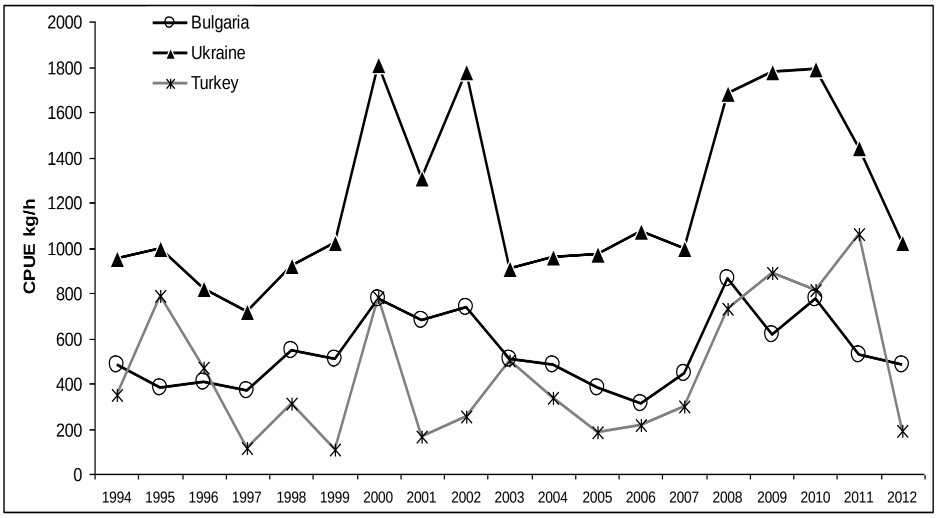

Fig. 6.1.2.5.1. CPUE $kg*h^{-1}$ derived from commercial fishery in Bulgaria, Ukraine and Turkey.

Peacks in the Turkish CPUE can be observed in 2005, 2006, 2007 and especially in 2008, 2009, 2010 and 2011 fishing periods. Sprat landing sharply decreased in 2012 (Table 6.1.2.5.1.). The Turkish sprat production increased slightly by the beginning of 2000s, remarkably by 2006 and nearly reached ten times by 2011. Trends in total catch were similar to the increase in vessel number. While total landings were between 1000-3000 tons at the end of 1990s, it was recorded as 50, 60 and 80 thousand tons at the three fishing periods; 2009, 2010 and 2011 respectively. Then it was again decreasing trend last two fishing season in 2012 and 2013 (Figure 6.1.2.5.2.).

Table 6.1.2.5.1. Time series sprat fishery fleet and total landing data (sources from TUIK Fishery Statistics)

Years	Total landing (tons)	No of vessels	CPUE (tons/year/vessel)
1993	640	2	320,0
1994	700	2	350,0
1995	1570	2	785,0
1996	937	2	468,5
1997	468	4	117,0
1998	1236	4	309,0
1999	421	4	105,3
2000	6225	8	778,1
2001	1008	6	168,0
2002	2 050	8	256,3
2003	6 025	12	502,1
2004	5 411	16	338,2
2005	5 500	30	183,3
2006	7 311	34	215,0
2007	11 921	40	298,0
2008	39 303	54	727,8
2009	53 385	60	889,8
2010	57 023	70	814,6
2011	87 141	82	1062,7

2012	12091.7	64	188.9
2013	9764	60	162,7

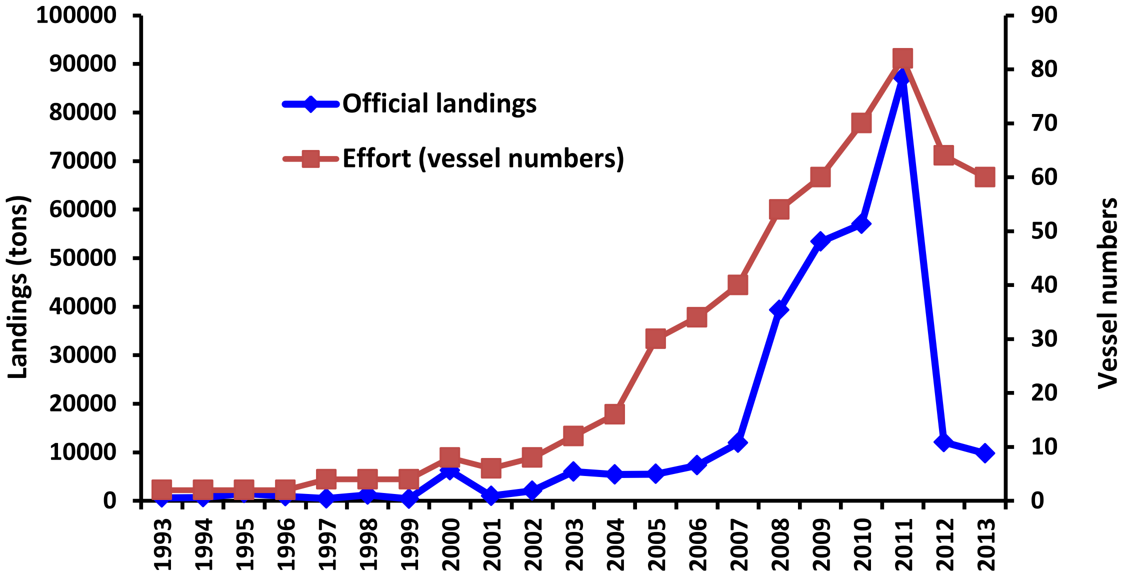

Figure 6.1.2.5.2. Data regarding the sprat landing and vessel number between 1993 and 2013 in Samsun Shelf Area (SSA). The whole total landing is processed by fish oil and flour fabrics operating in the region.

Pelagic trawl vessels are generally 18-30 m in length. Though the number of vessels licensed for pelagic fishery is totally 120, only 60 of them actively operated in 2013 fishing period. Actually, the fleet is dynamic and the number of vessels operating on sprat changes throughout the years. The smallest of these licensed vessels was 14.9 m and the biggest is 32.2 m. Mean length was estimated as 22.7 cm, 71.1% of vessels are over 20 m length and the rest percent 28.3 are 19 m and below. The size distribution has a mode around 22 and 23 m of length. Engine power ranges between 140 HP and 970 HP. The mean engine power of this fleet is approximately 415.7 HP and the mode appears around 300 HP.

The sprat fishery in Turkey started at the beginning of 2000s and increased rapidly in the last decade in the Turkish coasts. For this reason, perhaps being the unique population in Turkish coasts that has not been previously exploited–or slightly exploited-the sprat population may likely give response to heavy exploitation in future years. The parameters of fishery until 2010 do not reflect a fishing pressure on population but threatening is the steadily increased fishing effort. Another important indicator can be mentioned: the growing demand on sprat by the regional fishing industry producing fish oil and meal. The whole catch directly goes to processing. No discards on board have been observed.

The mesh size in pelagic trawl nets used for sprat fishery is 12 mm in Samsun Shelf Area. It can be concluded that the actual fishery already using 12 mm mesh size do not have any negative impact on the immature population in the Samsun Shelf Area.

Table 6.1.1.2.5.2 describes the dynamics of Ukrainian commercial fleet CPUE targeting sprat in 2013.

Table 6.1.2.5.2. CPUE kg/h *1000 of Ukrainian fishing vessels. 1996-2012 (Shlyakhov et al.. 2012)

Ukrainian commercial fleet CPUE kg*h-1 by years and quarters					
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	average
1996	0.41	0.96	1.27	0.64	820
1997	0.36	0.84	1.11	0.56	720
1998	0.46	1.08	1.42	0.72	920
1999	0.5	1.2	1.58	0.8	1020
2000	0.85	2.22	2.8	1.41	1820
2001	0.65	1.55	2	1.03	1310
2002	0.85	2.12	2.75	1.39	1780
2003	0.45	1.1	1.45	0.65	910
2004	0.4	1.2	1.5	0.75	960
2005	0.48	1.1	1.55	0.75	970
2006	0.5	1.25	1.67	0.85	1070
2007	0.45	1.2	1.55	0.8	1000
2008	0.83	2	2.6	1.3	1680
2009	0.85	2.1	2.75	1.4	1780
2010	0.8	2.15	2.8	1.4	1790
2011	0.55	1.77	2.17	1.15	1440
2012	240	1580	1710	550	1020
2013	n/a	n/a	n/a	n/a	870

6.1.3 Scientific surveys

6.1.3.1 Method 1 Pelagic survey in EU waters

Stratified sampling methodology was applied in Bulgarian (for the period of 2007-2010 by Raykov et al. 2007; Raykov. 2008; Raykov et al.. 2008;Raykov et al.. 2009; Raykov et al.. 2010; Raykov et al., 2011; Raykov et al., 2013) and Romanian waters (Radu et al.. 2010a; Radu et al.. 2010b; Radu et al.. 2010c).Taking into account exact depths (isobaths) the whole area was divided in sub areas ("strata"), respectively in the range 15-35 m, 35-50 m, 50-75m and 75-100m. The examined area was divided into equal sized fields - with a total number of 55; each sector equal to about 63 км2 (5' Lat. × 5' Long.). The trawling activities were carried out in meridian direction. The duration of each haul was 60 min; average velocity 2.8 knots (5.19 km* h-1). Biological data collection using mid-water trawl supplied scientists with valuable information of population parameters such as size, age, sex composition, condition (Fulton's coefficient) and relative indices of abundance. The CPUE derived from pelagic surveys was used for tuning series in the ICA for sprat.

Pelagic survey under DCF was conducted in spring 2013 only in Romanian waters. During the surveys the collected information included length (TL), weight, sex composition and maturity. Each survey includes 30-40 mid-water trawl hauls for 8-10 days. The pelagic trawl has the following dimensions: 57/63-62m, with horizontal opening of 22m. The average speed of the vessel was of 2.5 knots. The trawling time was standardized to 60 minutes, being realized 32 hauling.

In the Fig. 6.1.3.1.1. are presented the distribution of the sprat in the June, 2013 in Romanian waters.

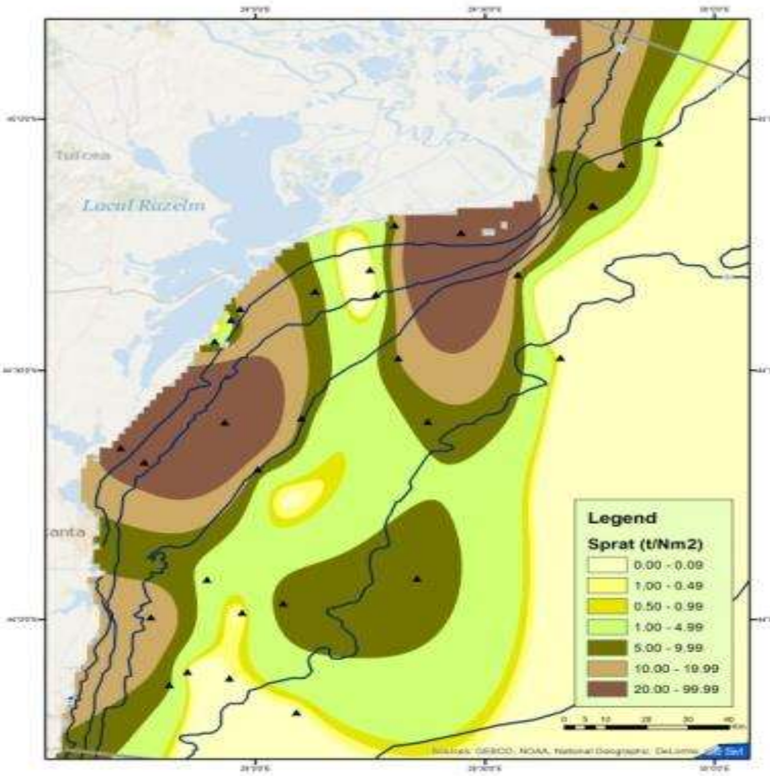

Figure 6.1.3.1.1. Distribution of the sprat agglomerations in 2nd Quarter 2013 in the Romanian marine waters

The Pelagic survey (PS) conducted in Romania in June 2013 covered Romanian waters from Sulina to Vama-Veche. Each hauling was with 30 min duration and was conducted according to "swept area" method (Sparre and Venema, 1992). Total number of hauling was 32 (strata: 0-35m (15 hauling); 35-50m (13 hauling) and 50-70m (4 hauling). The total amount of catch was 4530 kg. The estimated biomass in Romanian shelf was 56 428 tons.

Table 6.1.3.1.1. Assessment of sprat agglomerations in June 2013, pelagic trawl survey, Romanian area

Depth range (m)	0 - 30m	30 – 50m	50-70 m	Total
Investigated area (Nm^2)	625	887.5	87.5	1600
Variation of the catches (t/Nm^2)	1.755-89.977	0.00 – 16.894	0.00 – 6.74	0.00 – 89.977
Average catch (t/Nm^2)	23.96618	4.943529	3.37	11.2857
Biomass of the fishing agglomerations (t)	14978.86	4387.382	294.875	18057.266
Biomass extrapolated the Romanian shelf (t)				56428.955

6.1.3.2 Method 2 Hydroacoustic survey in EU waters

6.1.3.2.1 Geographical distribution patterns

There was only one hydroacoustic survey conducted in Bulgarian and Romanian waters in 2011.The target species of the survey in 2011 were European sprat (*Sprattus sprattus*) and whiting (*Merlangius merlangus*). The echo partitioning into species was based on echogram visual scrutinization. This was done either by direct allocation based on the identification of individual schools or allocation on account of representative fishing stations. Following the results from the survey abundance indices of the species sprat mono-specific catches were observed in 89.47 % of hauls composed by sprat over 75% of total weight (Panayotova et.al. 2012). Estimated relative sprat biomass is 48 201.70 t in the investigated area from which biomass of mature fish amounts of 48 173.18 t (Panayotova et.al, 2012).

No hydro acoustic surveys have been conducted in EU waters in 2013. Hydroacoustic survey in Turkish waters was conducted in 2013.

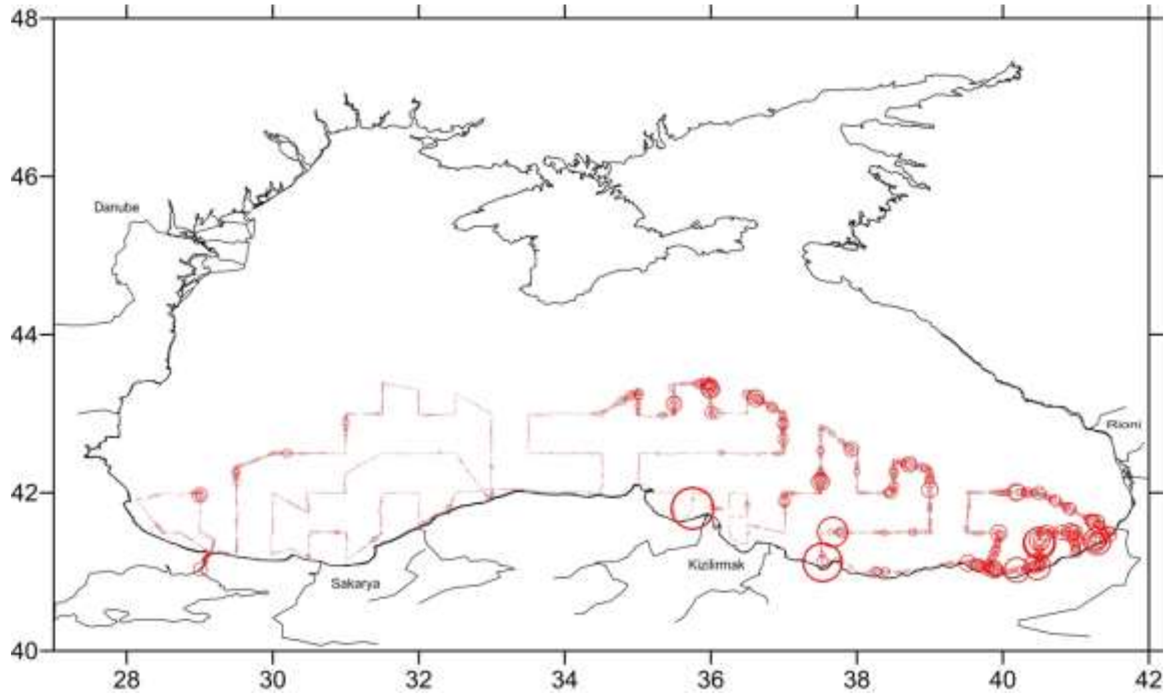

Figure 6.1.3.2.1.1 Hydroacoustic survey in Turkish waters conducted in 2013 with corresponding sprat agglomerations

The acoustically detected distribution sprat within the Turkish EEZ during summer 2013 is presented in the Figure 6.1.3.2.1.1. The biomass of the species is remarkably higher in the eastern part of the area surveys. The averaged biomass is estimated as 6.4 tons/na2 (423 552 tons within the Turkish EEZ). However this values should be treated with caution.

Hydroacoustically estimated biomass is 6.4 tons/na2
The biomass extrapolated over the Turkish EEZ is
Wmean = 0.58 g
Lmean = 4.9 cm
TSmean = - 57.4 (based on B20=-71.2)

6.1.3.2.2 Trends in abundance at length or age

The fishing gear and method for stock assessment for sprat in 2013 used in Romanian pelagic survey was in line with previous pelagic surveys, so we were able to compare abundance indices (derived in pelagic trawl surveys) with the previous assessments.

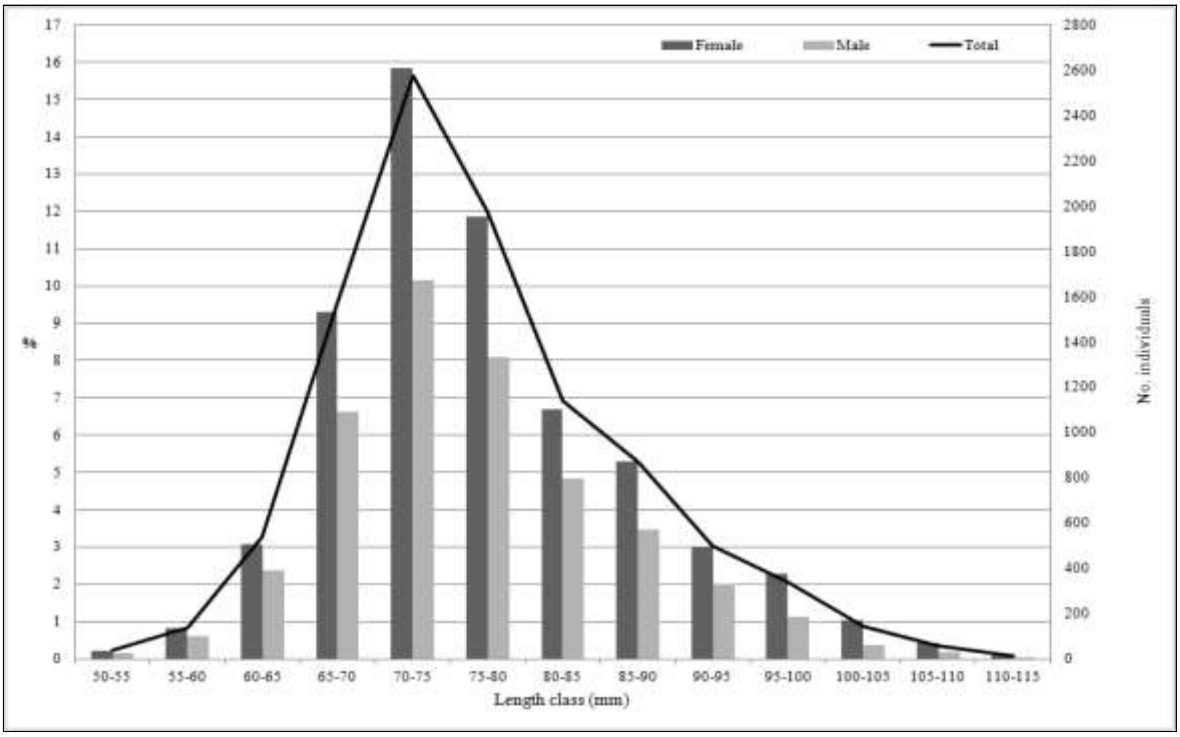

Figure 6.1.3.2.2.1. Length distribution of sprat from scientific survey in June, 2013.

Although sprat catches were low in 2013 (January - December), they were composed of mature specimens of 50 - 115 mm / 1.14 – 7.965 g, aged 1-3 years, the dominant classes are 65.5 - 90 mm / 1,87 - 3,98 g, 1 years (66.32%). Average body length was 76.88 mm and the average mass of 2.815 g. The sex ratio indicates a clear dominance of females (59.94%) than males (40.06%). The composition by age of sprat catches reveals the existence of specimens between 1 to 3 years. Most of the individuals are 1 years old (66.32%), followed closely by those of 2 years (29.19%) and of 3 years old (4.56%) Fig. 6.1.1.2.1. (Maximov, 2013).

Bulgarian catch length- frequency analyses show clear dominance of the 7.5 – 8.00 cm length classes, while the bigger fish were presented with lower percentage in the samples.
The age classes comprises 1 to 3+ years old individuals as 0+ while 4-5 age specimen are totally absent. (Fig. 6.1.3.2.2.2.)

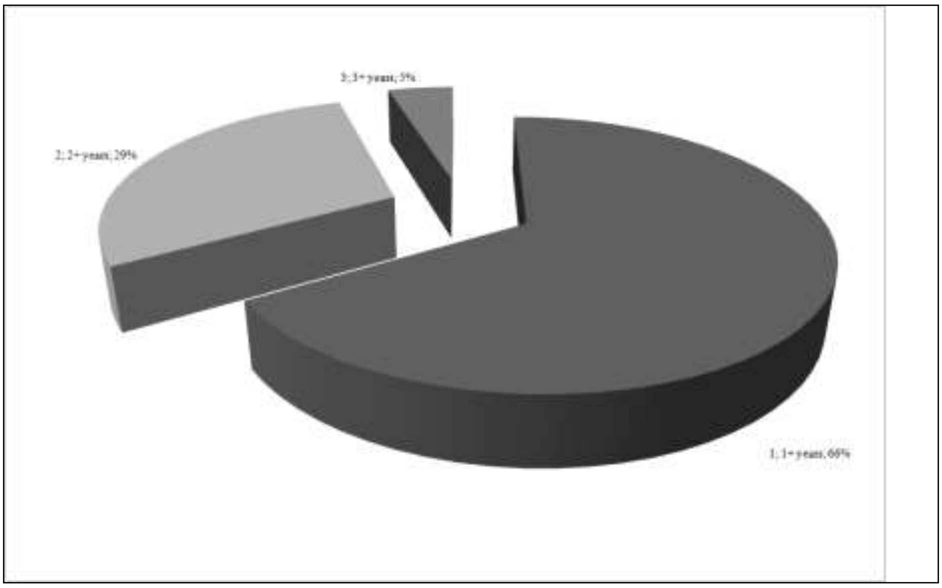

Figure 6.1.3.2.2.2. Age structure of sprat from June, 2013

6.1.3.2.3 Trends in growth

Length has trimodal distribution in terms of (70-75mm) (80-85mm) and (85-90mm). Sub dominated are the ranges 95-100mm and 105-110mm.

6.1.3.2.4 Trends in maturity

No trends of maturity have been conducted in 2013

6.1.3.2.5 Abundance and biomass

The mean catches per unit effort (CPUE) and abundance index (CPUA) in Turkish waters for 2013 are respectively 1508.4 kg/h and 1416,3 kg/km2 in trawl samplings conducted between 20 and 70 m (minimum 22.5 m, maximum 70.4 m) along the Samsun shelf area between first period of year (January-May) and last period of year (October-December) in 2013 (Table 6.1.3.2.5.1). Abundance indices were estimated by 'swept area method' (Sparre and Venema, 1992) for the same period by commercial vessels. Figure 6.1.3.2.5.1 show that distribution of biomass indices in SSA. The individual experience of fisherman and the quality of technical equipment of the vessel are determinative in the amount of daily catch. Sprat catch reaches its maximum especially in spring months; especially between March-May. But it showed that different decreasing CPUE and CPUA comprising in 2013. The monthly mean catches per unit effort (CPUE) is calculated for January 10650, February 8991, March 9044, April 7148, May 5000, October 6420, November 6908 and December 10668 respectively as kg/h/vessel (Figure 6.1.3.2.5.1).

Table 6.1.3.2.5.1. Descriptive data regarding catch effort (kg/h) and abundance indices (kg/km2) of sprat for 2013, in the Samsun shelf area (SSA)

Years	**No of hauls**	**Minimum**	**Maximum**	**Mean**	**Std. Error**
CPUE/2013	20	550	4000	**1508.4**	269.2
CPUA/2013	20	225	4090	**1416.3**	275.5

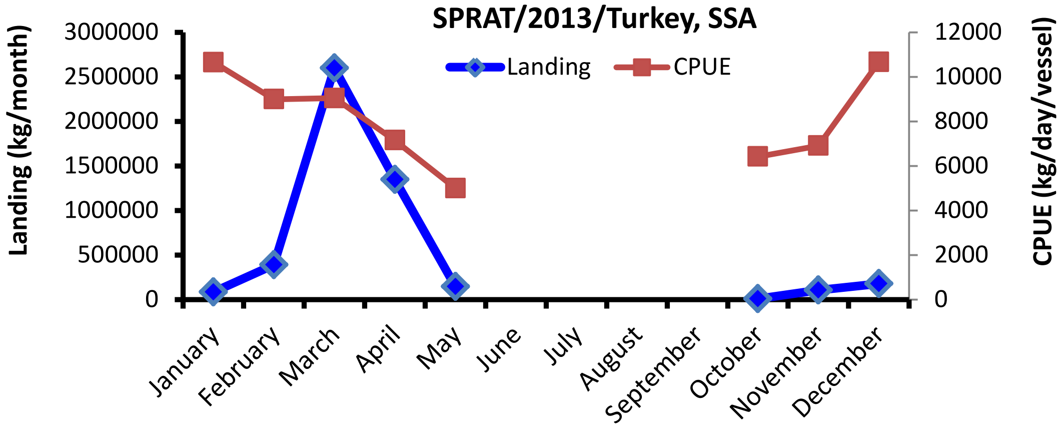

Figure 6.1.3.2.5.1. Monthly distribution of monthly and daily CPUE of sprat in Samsun Shelf Area, 2013

Biomass indices in the Samsun shelf area are presented on Figure 6.1.3.2.5.2

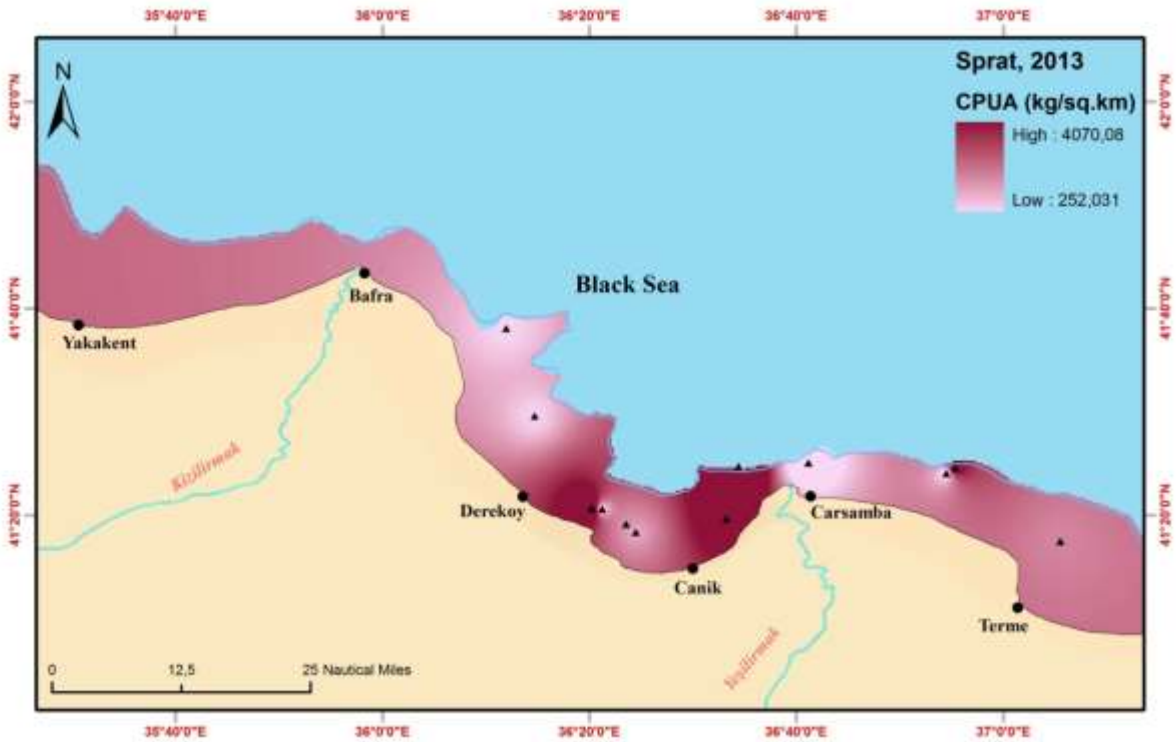

Figure 6.1.3.2.5.2. Map of the sprat biomass indices in the Samsun Shelf Area, 2013

6.1.4 Assessment of historical parameters

6.1.4.1 Method 1: ICA

6.1.4.2 Justification

We used Integrated Catch-at-age Analysis (ICA; Patterson and Melvin. 1996). ICA is a statistical catch-at-age method based on the Fournier and Deriso models (Deriso et al.. 1985). It applies a statistical optimization procedure to calculate population numbers and fishing mortality coefficients-at-age from data of catch numbers-at-age and natural mortality. The dynamics of a cohort (generation) in the stock are expressed by two non-linear equations referred to as a survival equation (exponential decay) and a catch equation:

$N_{a+1,y+1} = N_{a,y} * \exp(-F_{a,y} - M)$.

Ca.y = Na.y *[1 – exp(–Fa.y – M)]* Fa.y / (Fa.y + M).

where C. N. M. and F are catch, abundance, natural mortalit and fishing mortality respectively; a and y are subscript indices for age and year.

The algorithm initially estimates population numbers and fishing mortality fitting a separable model. when F is assumed to conform to a constant selection pattern (fishing mortality-at-age), but fishing mortality by year is allowed to vary. The F matrix is then modelled as a multiplication of the year-specific F and the specified selection pattern. This procedure substantially diminishes the number of parameters in the model.

In its second stage, the ICA algorithm minimizes the weighted Sum of Square Residuals (SSR) of observed and modelled catch and relative abundance indices (CPUE), assuming Gaussian distribution of the log residuals:

min [Σa.y pca.y (log Ca.y – log Ĉa.y)2 + Σa.y.f pia.f (log Ia.y.f – log Î a.y.f)2.

where C, Ĉ, I, and Î are observed and estimated catch and age-structured index, Respectively, and a, y, and f are subscript indices for age, Year, and fleet, respectively. Weights associated with catches and different indices (pc, pi) are ideally set equal to the inverse variances of catch and index data, and can be calculated based on the residuals between modelled and observed values. However, weights are usually set by the user on the basis of some information about the reliability of different indices and current experience with modelling the stock. Indices are defined as related to population numbers by the equations:

Î a.y = Na.y*exp(–Fa.y – M)
Î a.y = qa*Na.y*exp(–Fa.y – M)
Î a.y = qa*(Na.y*exp(–Fa.y – M))ka .

The two unknown parameters (qa, an age-specific catchability, and k, a constant) are estimated according to the assumed relationship between the population and the abundance index, which has to be specified as being one of the above – identity, Linear, or power, respectively.
ICA combines the power and accuracy of a statistical model with the flexibility of setting different options of the parameters (e.g. a separable model accounting for age effects) and for this reason is suitable for a short living species (age 5 at maximum) such as the Black Sea sprat. ICA has previously been applied to Black Sea sprat by Daskalov (1998) and Daskalov et al. 2010, 2011, and 2012.

6.1.4.3 Input parameters

Catch and weight at age, natural mortality, and 3 age structured indices are used to run ICA (Table 6.1.4.3.1).

Total catch at age data were compiled by summing catch at age matrices from Bulgaria, Romania, Russia, Turkey and Ukraine. Catch at age matrix from Russia was derived by applying age composition and mean weight in the catch of Ukraine to Russia catch. 3 age structured indices: CPUE from Bulgarian and Ukrainian commercial sprat fleets and a tuning index from the Romanian Pelagic Trawl Survey (PTS).

Table 6.1.4.3.1. ICA inputs

SPRAT 2013

Catch in Number

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008

0	115.	21.	108.	278.	236.	1009.	406.	809.	415.	1202.	445.	528.	1158.	3180.	1299.
1	2072.	1712.	2496.	2741.	2278.	3838.	4877.	10352.	6829.	5654.	6878.	6024.	5976.	5351.	7774.
2	2182.	2792.	2773.	2600.	2831.	3086.	3340.	6646.	7655.	5454.	3580.	4652.	2705.	1876.	3248.
3	442.	418.	579.	830.	1741.	1302.	1313.	1269.	3090.	3024.	2666.	1602.	785.	802.	1327.
4	13.	13.	17.	43.	82.	121.	110.	109.	182.	674.	278.	372.	92.	113.	168.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

x 10 ^ 6

Catch in Number

AGE	2009	2010	2011	2012	2013
0	1558.	2934.	2581.	3861.	1811.
1	12266.	7940.	10080.	4468.	5009.
2	7833.	7120.	12677.	2882.	3129.
3	3278.	4378.	8236.	1106.	588.
4	369.	316.	377.	97.	37.
5	0.	6.	14.	0.	1.

x 10 ^ 6

Predicted Catch in Number

AGE	2008	2009	2010	2011	2012	2013
0	1811.	2127.	1515.	3173.	3200.	1811.
1	5263.	12541.	8524.	8256.	7316.	5834.
2	3407.	8857.	11363.	9340.	3783.	3082.
3	1455.	2918.	3549.	4734.	1442.	696.
4	187.	318.	255.	336.	108.	46.

x 10 ^ 6

Weights at age in the catches (Kg)

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	.002300	.002500	.002500	.002300	.002400	.002800	.002300	.001700	.001800	.001700	.001900	.002100	.002000	.001700	.002300
1	.003400	.003800	.003800	.003300	.004000	.003200	.003500	.002500	.002700	.002800	.002900	.003500	.003300	.003300	.003400
2	.004000	.004600	.005200	.004900	.005100	.005000	.004500	.004000	.004100	.004000	.004400	.004700	.004300	.004900	.004300
3	.004700	.005400	.006000	.006300	.007600	.006500	.006000	.006300	.005800	.006100	.006000	.006200	.006000	.007200	.005200
4	.007700	.006900	.007400	.007200	.009400	.007300	.007800	.006900	.007700	.006800	.007300	.007700	.007300	.008700	.007000
5	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000

Weights at age in the catches (Kg)

AGE	2009	2010	2011	2012	2013
0	.002400	.002100	.002100	.001600	.001800
1	.003100	.002900	.002700	.002200	.002100
2	.004000	.004400	.003700	.004200	.003300
3	.004900	.006500	.004600	.005500	.005000
4	.006000	.008000	.008700	.007100	.006800
5	.010000	.016000	.010000	.010000	.010000

Weights at age in the stock (Kg)

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000
1	.003500	.003300	.002800	.002700	.003400	.002500	.003200	.003500	.003600	.003500	.003400	.003600	.003600	.003600	.003100
2	.004100	.004300	.004300	.004700	.004600	.004700	.004400	.004400	.004500	.004400	.004400	.004600	.004600	.004700	.004200
3	.004800	.004800	.004700	.005700	.006400	.005900	.005600	.005200	.006100	.005900	.006000	.006100	.005700	.006300	.005600
4	.006200	.005500	.005300	.006900	.008200	.007300	.007200	.006700	.007400	.007400	.007200	.007400	.007400	.007600	.007000
5	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000

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Weights at age in the stock (Kg)

AGE	2009	2010	2011	2012	2013
0	.001000	.001000	.001000	.001000	.001000
1	.003100	.002500	.003000	.002600	.001600
2	.004100	.003500	.004000	.003900	.004100
3	.004700	.004500	.004800	.005500	.004800
4	.005400	.007100	.007300	.007900	.008000
5	.010000	.016000	.010000	.010000	.010000

Natural Mortality (per year)

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000
1	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
2	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
3	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
4	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
5	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000

Natural Mortality (per year)

AGE	2009	2010	2011	2012	2013
0	0.64000	0.64000	0.64000	0.64000	0.64000
1	0.95000	0.95000	0.95000	0.95000	0.95000
2	0.95000	0.95000	0.95000	0.95000	0.95000
3	0.95000	0.95000	0.95000	0.95000	0.95000
4	0.95000	0.95000	0.95000	0.95000	0.95000
5	0.95000	0.95000	0.95000	0.95000	0.95000

Proportion of fish spawning

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	2009	2010	2011	2012	2013
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000

2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000

AGE-STRUCTURED INDICES

Bul

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	9.78	19.59	41.06	53.32	52.36	101.06	106.86	103.05	74.39	56.86	65.51	42.09	40.59	57.25	79.25
2	57.49	48.77	38.16	28.37	58.52	30.60	76.34	71.10	71.11	49.82	44.34	27.74	21.64	32.98	71.84
3	16.27	7.36	9.45	6.21	5.28	4.54	6.95	4.03	23.08	14.35	15.94	9.36	4.21	10.17	51.88
4	0.25	0.23	0.59	0.61	0.54	0.30	0.67	0.23	1.25	2.57	3.93	0.94	1.30	1.73	5.16

x 10 ^ 3

Bul

AGE	2009	2010	2011	2012	2013
1	66.13	63.39	40.34	105.34	122.17
2	57.91	69.21	44.02	50.49	59.55
3	19.69	53.15	32.18	9.83	11.10
4	3.16	6.08	4.77	2.10	0.14

x 10 ^ 3

Ukr

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	124.38	80.94	111.12	58.09	59.67	97.40	222.49	193.27	158.30	76.22	125.47	113.57	180.31	127.15	284.84
2	74.90	103.68	118.27	50.40	68.14	85.43	146.35	118.28	179.30	76.02	46.40	88.14	69.18	24.19	55.49
3	8.05	9.43	9.43	10.52	46.52	37.49	66.40	22.53	76.56	47.52	54.76	29.98	24.67	16.90	37.53
4	0.51	0.14	0.66	0.72	2.36	0.56	6.10	2.15	4.65	10.87	5.06	8.06	2.52	0.10	3.07

x 10 ^ 3

Ukr

AGE	2009	2010	2011	2012	2013
1	335.38	352.09	253.76	188.67	161.04
2	143.30	67.33	70.76	54.05	80.10
3	37.47	4.84	14.37	20.49	6.75
4	0.66	0.24	0.11	2.35	0.37

x 10 ^ 3

Rom survey

AGE	2007	2008	2009	2010	2011	2012	2013
1	20571.	72155.	53939.	999990.	999990.	79615.	45054.
2	26498.	40969.	72325.	999990.	999990.	39609.	19760.
3	14120.	11359.	14361.	999990.	999990.	11247.	311.

6.1.4.4 Results

ICA was run assuming a constant selection pattern in 2007-2013 (Fig. 6.1.4.4.2. Table 6.1.4.4.1) with reference F at age 2 and Selection at the last 'real' age (S4) equal 1.

The results of the ICA show a reasonable agreement with tuning data (Fig. 6.1.4.4.3. Fig. 6.1.4.4.4. Fig. 6.1.4.4.5). The overall fit and partial SSR converged to unique minima (Fig. 6.1.4.4.1). Retrospective analyses show no systematic deviations (Fig. 6.1.4.4.6).

Analyses of the main population parameters (abundance, catch, fishing mortality, Fig. 6.1.4.4.7 Table 6.1.4.4.1.) indicate that the sprat stock has recovered from the depression in the 1990s due to good recruitment in 1999-2001 and the biomass and catches have gradually increased over the 1990s and during the 2000s reached levels comparable to the previous periods of high abundance (Fig. 6.1.4.4.8). The stock estimates reveal the cyclic nature the sprat population dynamics. The years with strong recruitment were followed by years of low to medium recruitment which leads to corresponding changes in the Spawning Stock Biomass (SSB). High fishing mortalities (F_{1-3}) were observed during the stock collapse in the early 1990s in 2004-2005 and 2010-2012. In 2011 the highest ever total catch of 120 708t (Table 6.1.2.5.1) was recorded due mainly to the intensive development of the Turkish sprat fishery. Over 2007-2010 years the levels of biomass and catches were comparable with the highest figures reported, but in 2009-2011 - a decreasing trend in recruitment becomes evident (Fig. 6.1.4.4.7A). In the last couple of years catches dropped more than 3 times, and SSB is estimated at the level of about 180 000t. Due to lower catches average fishing mortality dropped from 1.24 in 2011 to 0.446 in 2013.

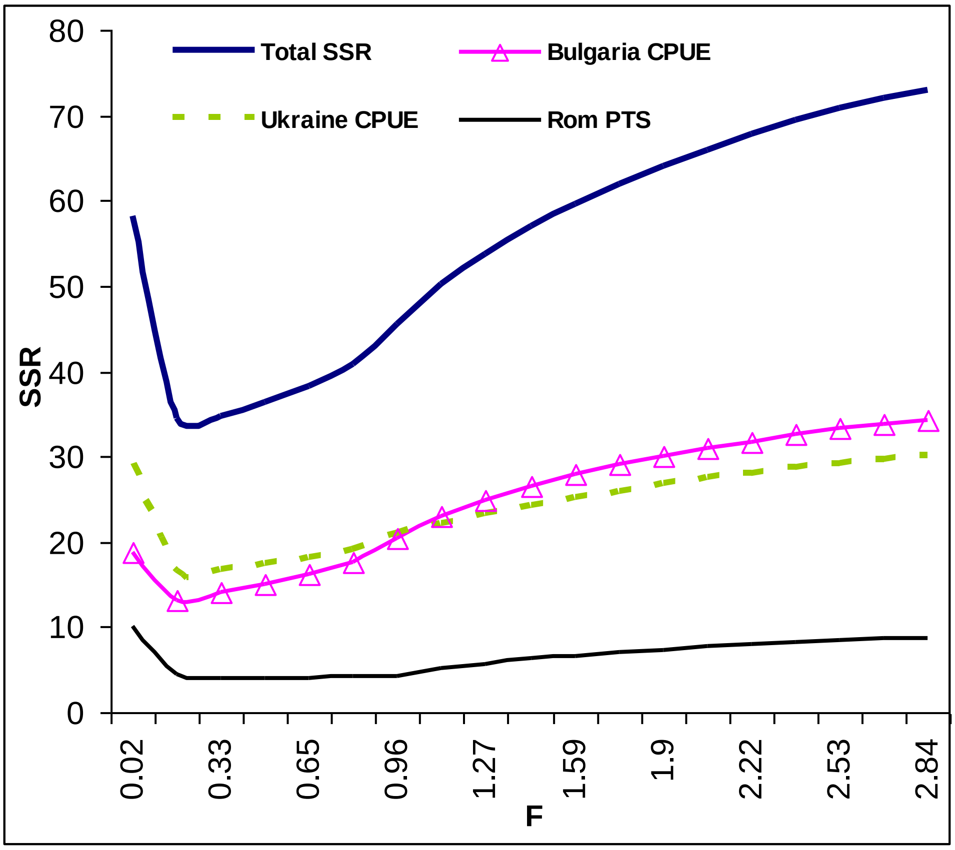


Fig. 6.1.4.4.1 Trajectories of the total Sum of Squared Residuals (SSR) and the partial SSRs of the two tuning fleets as functions of the reference F.

Fig. 6.1.4.4.2. Selection pattern estimated by the separable model

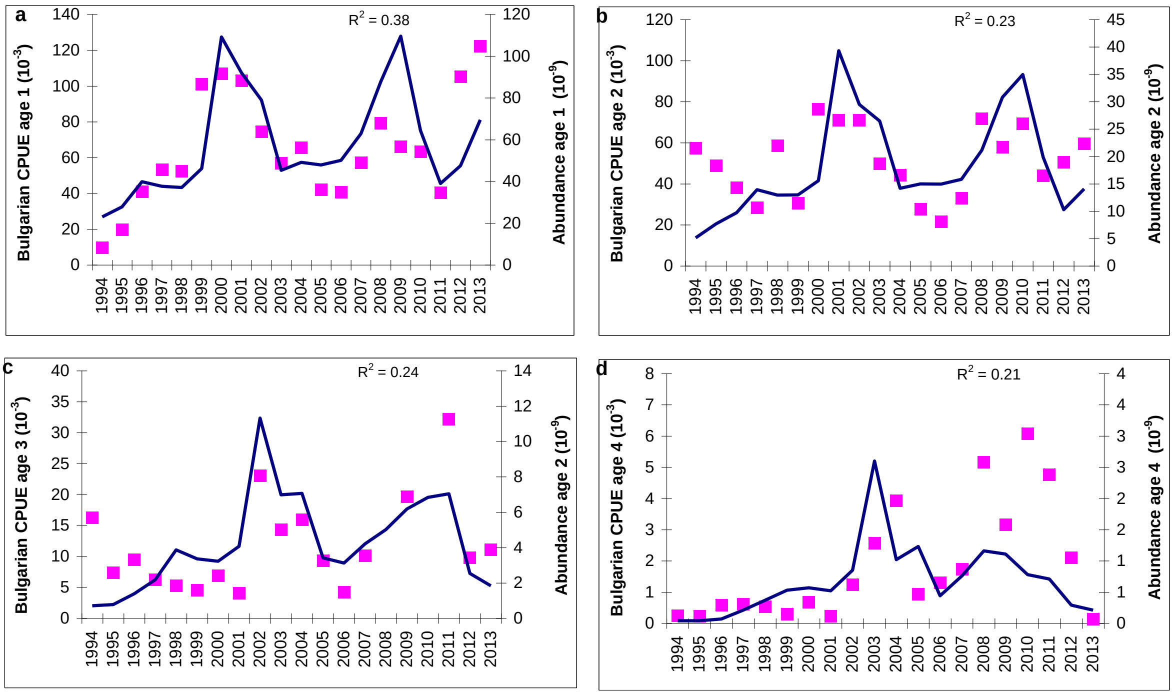


Fig. 6.1.4.4.3. Adjustment of ICA: time-series of estimated abundance-at-age and age-structured Bulgarian CPUE (best fit is given by linear relationships and r^2 are displayed): (a) Age 1. (b) Age 2. (c) Age 3. (d) Age 4.

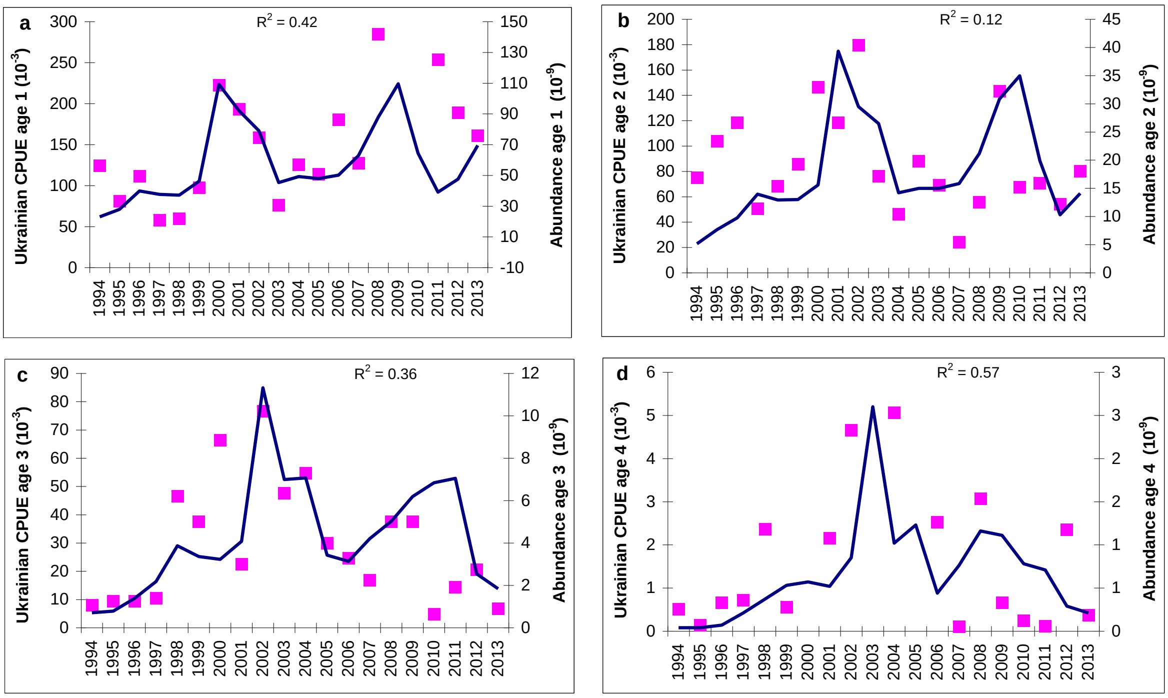


Figure 6.1.4.4.4. Adjustment of ICA: time-series of estimated abundance-at-age and age-structured Ukrainian CPUE (best fit is given by linear relationships and r^2 are displayed): (a) Age 1. (b) Age 2. (c) Age 3. (d) Age 4.

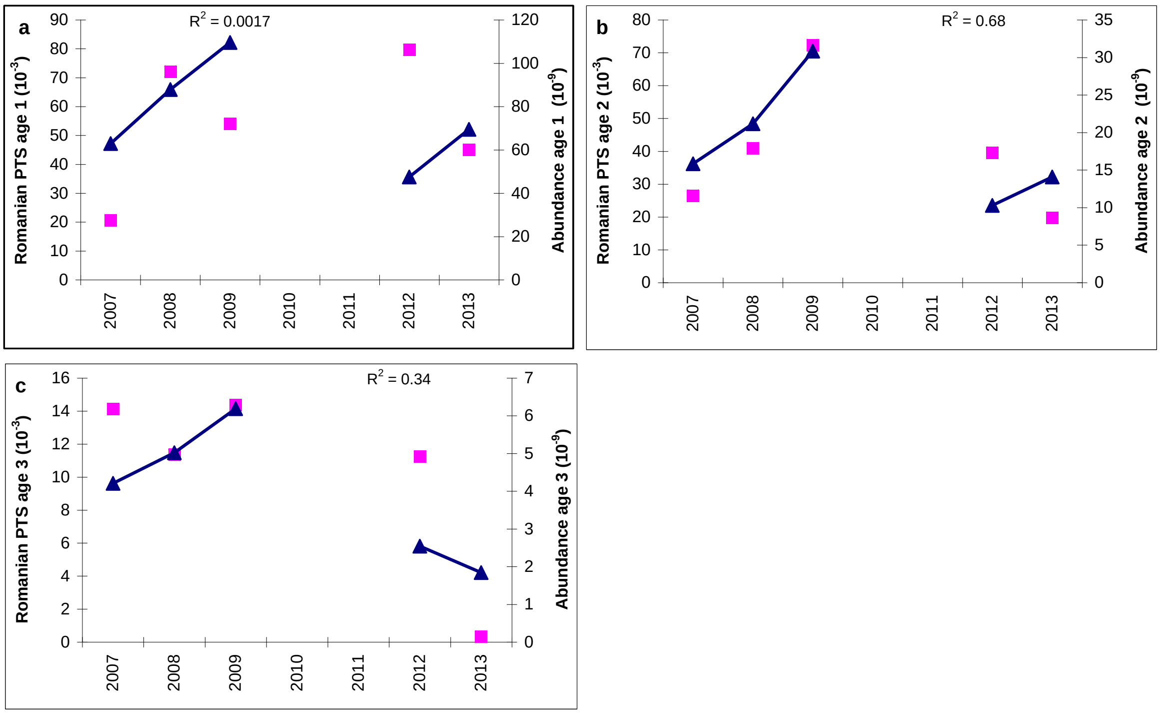


Figure 6.1.4.4.5. Adjustment of ICA: time-series of estimated abundance-at-age and age-structured Romanian PTS (best fit is given by linear relationships and r^2 are displayed): (a) Age 1. (b) Age 2. (c) Age 3.

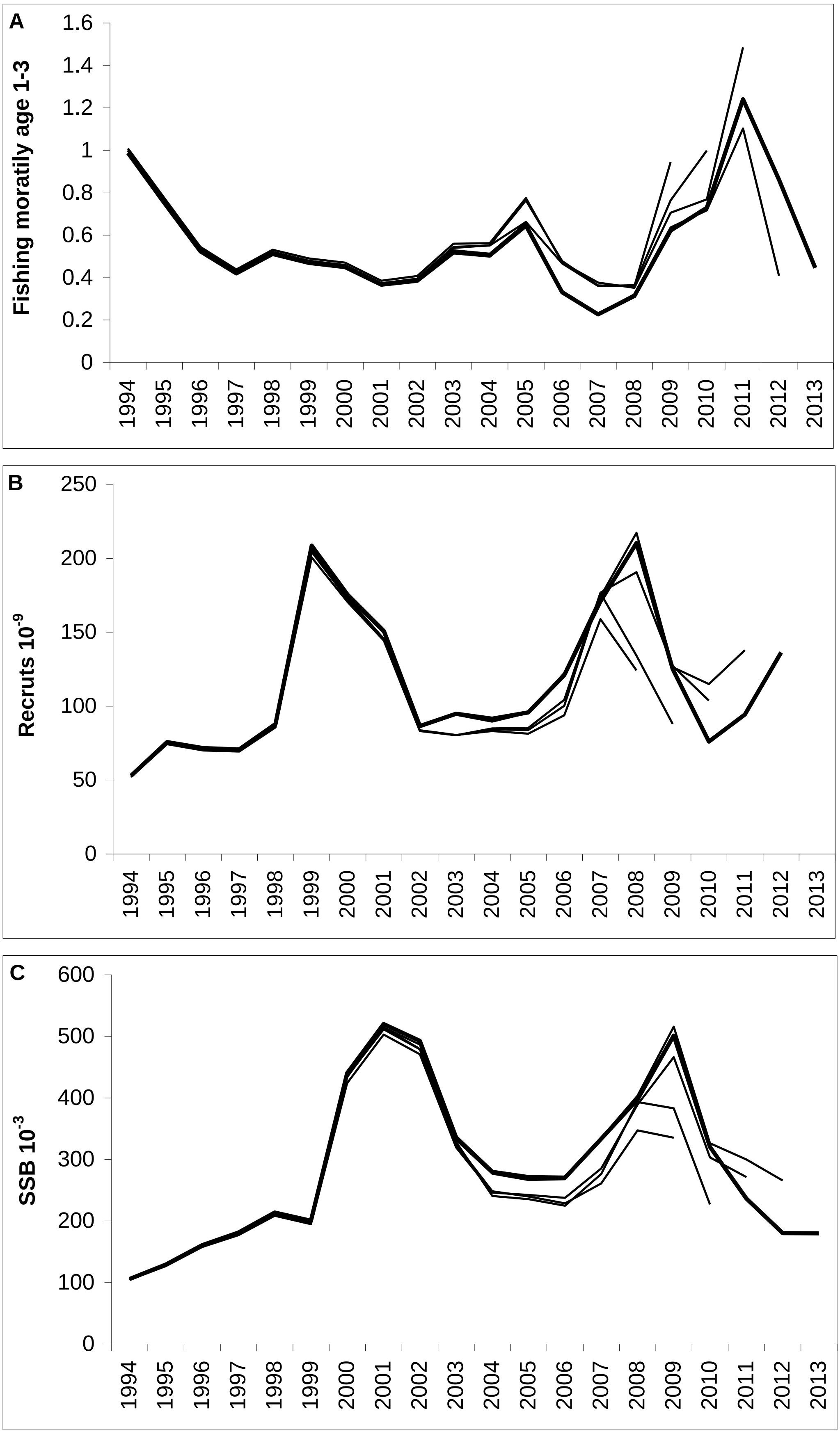
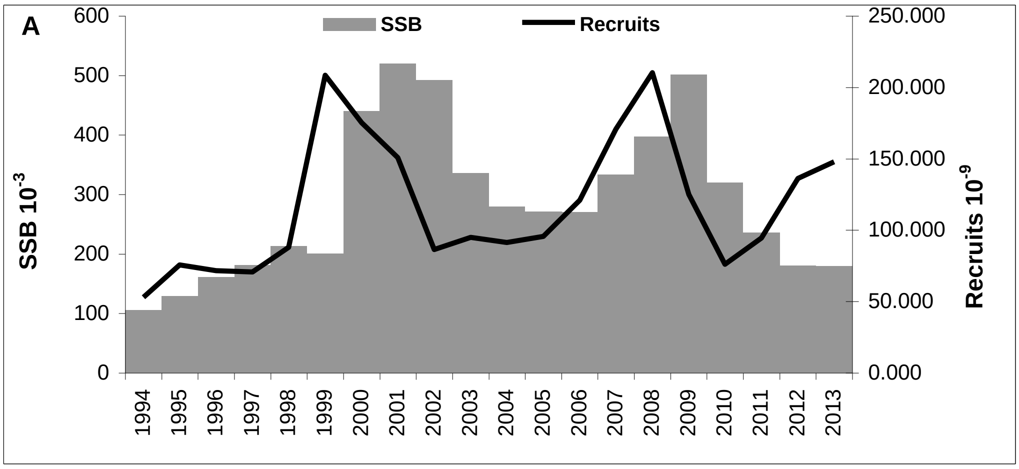


Fig. 6.1.4.4.6. Retrospective analyses of ICA on sprat



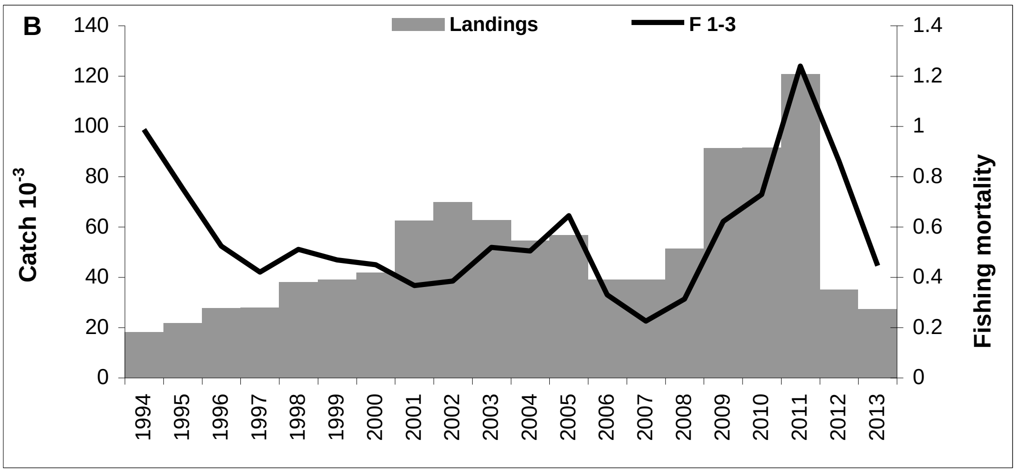


Fig. 6.1.4.4.7 Time-series of sprat population estimates: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2–4. line).

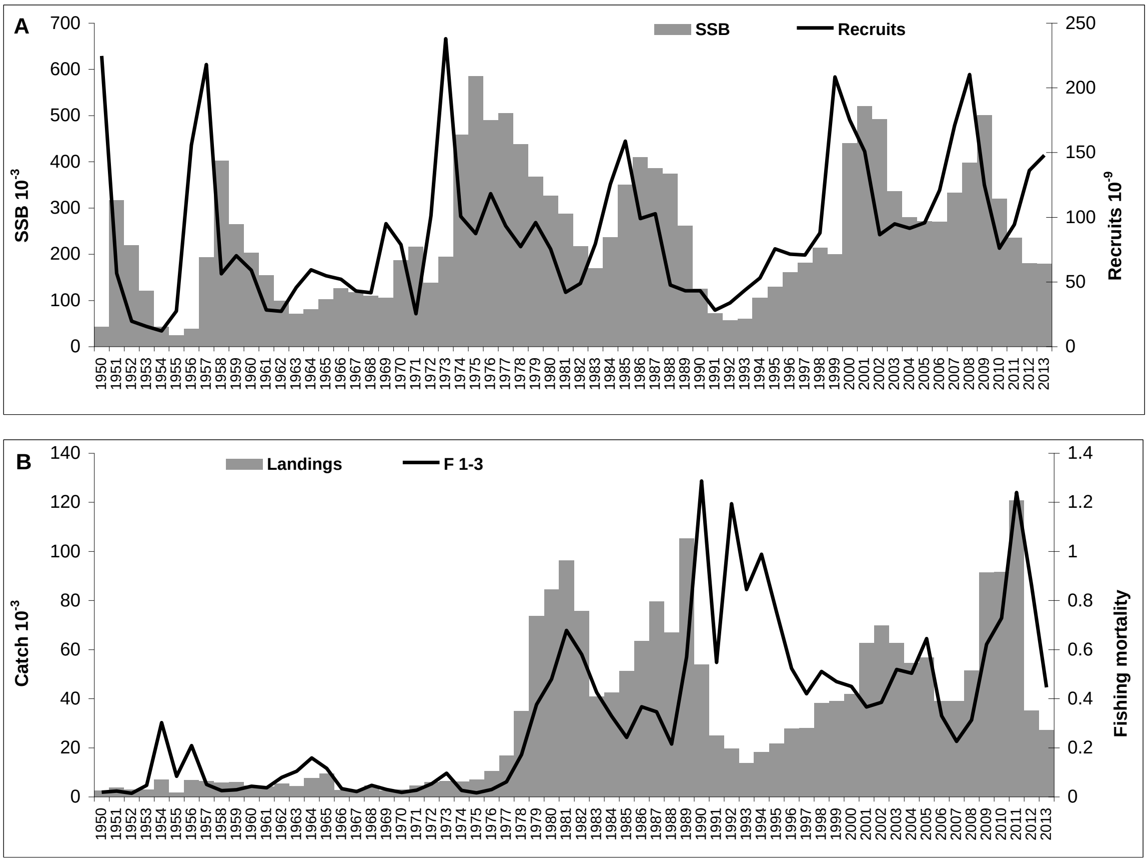


Fig. 6.1.4.4.8 Time-series of sprat population estimates – present results combined with historical estimates from Daskalov 1998: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2–4. line).

Table 6.1.4.4.1. Sprat in the Black Sea: ICA results and diagnostics.

Fishing Mortality (per year)

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0.0030	0.0004	0.0020	0.0053	0.0036	0.0066	0.0031	0.0073	0.0065	0.0173	0.0066	0.0075	0.0130	0.0255	0.0117
1	0.1483	0.0993	0.1012	0.1186	0.0992	0.1363	0.0713	0.1883	0.1422	0.2110	0.2392	0.2129	0.2009	0.1396	0.0967
2	0.9441	0.7586	0.5489	0.3310	0.3988	0.4399	0.3891	0.2956	0.4897	0.3712	0.4734	0.6148	0.3191	0.1991	0.2799
3	1.8709	1.3999	0.9206	0.8097	1.0352	0.8313	0.8874	0.6149	0.5215	0.9746	0.7989	1.1058	0.4698	0.3392	0.5620
4	0.7684	0.5811	0.4334	0.3592	0.4005	0.4162	0.3458	0.3823	0.3870	0.4892	0.5212	0.5940	0.3782	0.2574	0.2799
5	0.7684	0.5811	0.4334	0.3592	0.4005	0.4162	0.3458	0.3823	0.3870	0.4892	0.5212	0.5940	0.3782	0.2574	0.2799

Fishing Mortality (per year)

AGE	2009	2010	2011	2012	2013
0	0.0233	0.0273	0.0465	0.0323	0.0167
1	0.1920	0.2252	0.3831	0.2662	0.1377
2	0.5559	0.6519	1.1091	0.7708	0.3988
3	1.1163	1.3090	2.2272	1.5478	0.8008
4	0.5559	0.6519	1.1091	0.7708	0.3988
5	0.5559	0.6519	1.1091	0.7708	0.3988

Population Abundance (1 January)

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	52.95	75.62	71.52	70.69	87.87	208.45	175.17	150.80	86.44	94.87	91.37	95.70	120.87	170.84	210.23
1	23.03	27.84	39.86	37.64	37.08	46.16	109.19	92.08	78.94	45.28	49.17	47.86	50.08	62.91	87.81
2	5.15	7.68	9.75	13.93	12.93	12.98	15.58	39.32	29.50	26.48	14.18	14.97	14.96	15.84	21.16
3	0.71	0.78	1.39	2.18	3.87	3.36	3.23	4.08	11.32	6.99	7.07	3.42	3.13	4.21	5.02
4	0.04	0.04	0.07	0.21	0.37	0.53	0.57	0.52	0.85	2.60	1.02	1.23	0.44	0.76	1.16
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

x 10 ^ 9

Population Abundance (1 January)

AGE	2009	2010	2011	2012	2013	2014
0	124.95	76.04	94.37	136.11	147.84	150.54
1	109.56	64.37	39.02	47.50	69.49	76.66
2	30.83	34.97	19.87	10.29	14.08	23.42
3	6.19	6.84	7.05	2.54	1.84	3.65
4	1.11	0.78	0.71	0.29	0.21	0.32
5	0.00	0.02	0.03	0.00	0.01	0.06

x 10 ^ 9

Weighting factors for the catches in number

AGE	2008	2009	2010	2011	2012	2013
0	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted Age-Structured Index Values

Bul Predicted

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	24.70	30.60	43.77	40.98	40.76	49.82	121.73	96.81	84.93	47.08	50.40	49.71	52.33	67.77	96.66
2	12.26	20.06	28.28	45.06	40.42	39.77	48.94	129.47	88.13	83.95	42.72	42.01	48.68	54.74	70.21
3	1.55	2.15	4.91	8.12	12.90	12.38	11.61	16.79	48.77	24.02	26.51	10.99	13.84	19.85	21.21
4	0.07	0.10	0.18	0.55	0.94	1.32	1.45	1.30	2.15	6.22	2.41	2.79	1.11	2.04	3.08

x 10 ^ 3

Bul Predicted

AGE	2009	2010	2011	2012	2013
1	114.98	66.44	37.22	48.03	74.93
2	89.12	96.34	43.56	26.70	44.01
3	19.80	19.88	12.94	6.54	6.90
4	2.57	1.73	1.26	0.61	0.52

x 10 ^ 3

Ukr Predicted

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	63.22	78.32	112.03	104.87	104.31	127.49	311.53	247.76	217.36	120.48	128.98	127.22	133.92	173.44	247.37
2	20.14	32.94	46.44	74.01	66.39	65.32	80.39	212.64	144.75	137.89	70.16	69.01	79.95	89.91	115.31
3	2.94	4.07	9.29	15.38	24.41	23.44	21.97	31.77	92.28	45.45	50.16	20.80	26.20	37.56	40.13
4	0.08	0.11	0.20	0.60	1.04	1.46	1.61	1.44	2.38	6.87	2.66	3.09	1.22	2.25	3.40

x 10 ^ 3

Ukr Predicted

AGE	2009	2010	2011	2012	2013
1	294.26	170.04	95.24	122.93	191.77
2	146.37	158.23	71.55	43.86	72.29

AGE					
3	37.46	37.62	24.49	12.38	13.05
4	2.83	1.91	1.39	0.68	0.58

x 10 ^ 3

Rom survey Predicted

AGE	2007	2008	2009	2010	2011	2012	2013
1	43253.	61690.	73383.	999990.	999990.	30656.	47824.
2	37585.	48203.	61188.	999990.	999990.	18335.	30218.
3	9203.	9831.	9178.	999990.	999990.	3032.	3198.

Fitted Selection Pattern

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0.0031	0.0005	0.0037	0.0162	0.0091	0.0149	0.0081	0.0247	0.0133	0.0466	0.0140	0.0122	0.0409	0.1280	0.0419
1	0.1571	0.1309	0.1843	0.3581	0.2488	0.3099	0.1832	0.6371	0.2904	0.5686	0.5053	0.3463	0.6295	0.7013	0.3454
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.9817	1.8455	1.6770	2.4458	2.5955	1.8898	2.2807	2.0803	1.0649	2.6258	1.6878	1.7986	1.4722	1.7032	2.0081
4	0.8139	0.7660	0.7896	1.0850	1.0043	0.9461	0.8888	1.2935	0.7903	1.3179	1.1011	0.9661	1.1852	1.2929	1.0000
5	0.8139	0.7660	0.7896	1.0850	1.0043	0.9461	0.8888	1.2935	0.7903	1.3179	1.1011	0.9661	1.1852	1.2929	1.0000

Fitted Selection Pattern

AGE	2009	2010	2011	2012	2013
0	0.0419	0.0419	0.0419	0.0419	0.0419
1	0.3454	0.3454	0.3454	0.3454	0.3454
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	2.0081	2.0081	2.0081	2.0081	2.0081
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 3	SoP (%)
1994	52952770	158306	105354	18219	0.1729	1.4075	99
1995	75618970	204475	128856	21746	0.1688	1.0792	100
1996	71521830	231988	160466	27778	0.1731	0.7347	99
1997	70689180	251673	180984	27963	0.1545	0.5704	100
1998	87866660	301228	213361	38117	0.1786	0.7170	99

1999	208451090	408560	200109	39152	0.1957	0.6356	98
2000	175171320	615317	440145	41769	0.0949	0.6383	100
2001	150796860	670772	519975	62587	0.1204	0.4553	100
2002	86443290	578701	492258	69894	0.1420	0.5056	99
2003	94870920	430360	335489	62716	0.1869	0.6729	99
2004	91372270	370681	279309	54574	0.1954	0.6361	100
2005	95699350	366802	271103	56854	0.2097	0.8603	100
2006	120868310	391072	270203	39048	0.1445	0.3945	100
2007	170838100	504017	333179	39008	0.1171	0.2691	99
2008	210226210	607543	397317	51463	0.1295	0.4210	99
2009	124946880	626036	501089	91376	0.1824	0.8361	100
2010	76041620	395969	319928	91594	0.2863	0.9804	99
2011	94367690	330258	235890	120710	0.5117	1.6682	99
2012	136109560	315993	179883	35025	0.1947	1.1593	100
2013	147840780	327305	179464	27260	0.0152	0.5998	9

No of years for separable analysis : 6
Age range in the analysis : 0 . . . 5
Year range in the analysis : 1994 . . . 2013
Number of indices of SSB : 0
Number of age-structured indices : 3

Parameters to estimate : 30
Number of observations : 205

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

iParm.i i Maximum i i i i i i Mean of i
i No. i i Likelh. i CV i Lower i Upper i -s.e. i +s.e. i Param. i
i i i Estimatei (%)i 95% CL i 95% CL i i i Distrib.i

Separable model : F by year

1	2008	0.2799	25	0.1702	0.4602	0.2172	0.3607	0.2890
2	2009	0.5559	21	0.3618	0.8541	0.4465	0.6921	0.5694
3	2010	0.6519	21	0.4318	0.9842	0.5283	0.8043	0.6664
4	2011	1.1091	18	0.7761	1.5852	0.9244	1.3308	1.1277
5	2012	0.7708	20	0.5121	1.1602	0.6257	0.9496	0.7878
6	2013	0.3988	31	0.2137	0.7442	0.2901	0.5483	0.4195

Separable Model: Selection (S) by age

7	0	0.0419	32	0.0220	0.0799	0.0301	0.0582	0.0442
8	1	0.3454	23	0.2161	0.5521	0.2719	0.4388	0.3554
	2	1.0000	Fixed : Reference Age					
9	3	2.0081	17	1.4162	2.8473	1.6804	2.3997	2.0402
	4	1.0000	Fixed : Last true age					

Separable model: Populations in year 2013

10	0	147840780	74	34062143	641677065	69908146	312651636	195703686
11	1	69488623	33	35695375	135274353	49466453	97615019	73620114
12	2	14076253	24	8643233	22924398	10975399	18053185	14518855
13	3	1840543	23	1167721	2901035	1459238	2321485	1890813
14	4	208558	30	114078	381287	153300	283735	218677

Separable model: Populations at age

15	2008	1158509	37	552691	2428380	794166	1690004	1244114
16	2009	1107031	26	655629	1869224	847399	1446212	1147284
17	2010	783382	26	470357	1304727	603865	1016266	810370
18	2011	714391	26	425541	1199309	548457	930528	739788

19 2012 293863 29 166416 518912 219862 392771 306494

Age-structured index catchabilities

Bul

Linear model fitted. Slopes at age :

20 1 Q .1858E-02 19 .1545E-02 .3279E-02 .1858E-02 .2727E-02 .2293E-02
21 2 Q .6137E-02 19 .5107E-02 .1082E-01 .6137E-02 .9001E-02 .7570E-02
22 3 Q .8994E-02 19 .7476E-02 .1590E-01 .8994E-02 .1322E-01 .1111E-01
23 4 Q .4920E-02 19 .4073E-02 .8806E-02 .4920E-02 .7291E-02 .6106E-02

Ukr

Linear model fitted. Slopes at age :

24 1 Q .4754E-02 19 .3954E-02 .8393E-02 .4754E-02 .6980E-02 .5868E-02
25 2 Q .1008E-01 19 .8387E-02 .1777E-01 .1008E-01 .1478E-01 .1243E-01
26 3 Q .1702E-01 19 .1415E-01 .3009E-01 .1702E-01 .2501E-01 .2102E-01
27 4 Q .5432E-02 19 .4497E-02 .9723E-02 .5432E-02 .8050E-02 .6742E-02

Rom survey

Linear model fitted. Slopes at age :

28 1 Q .1186E-02 34 .8488E-03 .3322E-02 .1186E-02 .2378E-02 .1784E-02
29 2 Q .4214E-02 34 .3032E-02 .1162E-01 .4214E-02 .8365E-02 .6296E-02
30 3 Q .4170E-02 34 .2985E-02 .1168E-01 .4170E-02 .8362E-02 .6273E-02

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	2008	2009	2010	2011	2012	2013
0	-0.3325	-0.3113	0.6607	-0.2066	0.1877	0.0000
1	0.3900	-0.0221	-0.0710	0.1996	-0.4932	-0.1525
2	-0.0478	-0.1228	-0.4675	0.3055	-0.2723	0.0153
3	-0.0922	0.1163	0.2099	0.5538	-0.2652	-0.1685
4	-0.1028	0.1490	0.2170	0.1158	-0.1092	-0.2031

AGE-STRUCTURED INDEX RESIDUALS

Bul

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	-0.926	-0.446	-0.064	0.263	0.250	0.707	-0.130	0.062	-0.132	0.189	0.262	-0.166	-0.254	-0.169	-0.199
2	1.545	0.888	0.300	-0.463	0.370	-0.262	0.445	-0.599	-0.215	-0.522	0.037	-0.415	-0.811	-0.507	0.023
3	2.348	1.230	0.654	-0.269	-0.894	-1.003	-0.513	-1.426	-0.748	-0.515	-0.508	-0.161	-1.190	-0.669	0.895
4	1.202	0.886	1.169	0.103	-0.551	-1.492	-0.774	-1.729	-0.543	-0.886	0.492	-1.092	0.164	-0.162	0.515

Bul

Age	2009	2010	2011	2012	2013
1	-0.553	-0.047	0.081	0.785	0.489
2	-0.431	-0.331	0.010	0.637	0.302
3	-0.005	0.983	0.911	0.408	0.476
4	0.207	1.257	1.336	1.236	-1.332

Ukr

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.677	0.033	-0.008	-0.591	-0.559	-0.269	-0.337	-0.248	-0.317	-0.458	-0.028	-0.113	0.297	-0.310	0.141
2	1.313	1.147	0.935	-0.384	0.026	0.268	0.599	-0.587	0.214	-0.595	-0.414	0.245	-0.145	-1.313	-0.731
3	1.006	0.839	0.015	-0.379	0.645	0.470	1.106	-0.344	-0.187	0.044	0.088	0.366	-0.060	-0.799	-0.067
4	1.832	0.251	1.190	0.177	0.822	-0.964	1.335	0.405	0.671	0.458	0.645	0.960	0.722	-3.113	-0.103

Ukr

Age	2009	2010	2011	2012	2013
1	0.131	0.728	0.980	0.428	-0.175
2	-0.021	-0.854	-0.011	0.209	0.103
3	0.000	-2.051	-0.533	0.504	-0.659
4	-1.455	-2.066	-2.561	1.248	-0.450

Rom survey

Age	2007	2008	2009	2010	2011	2012	2013
1	-0.743	0.157	-0.308	*******	*******	0.954	-0.060
2	-0.350	-0.163	0.167	*******	*******	0.770	-0.425
3	0.428	0.145	0.448	*******	*******	1.311	-2.330

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 2008 to 2013
Variance 0.1679
Skewness test stat. 0.4197

Kurtosis test statistic	-0.3310
Partial chi-square	0.1237
Significance in fit	0.0000
Degrees of freedom	11

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR Bul

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0417	0.0848	0.2315	0.2535
Skewness test stat.	-0.1115	1.7507	1.1324	-0.2981
Kurtosis test statisti	0.1376	0.5124	-0.1582	-1.1481
Partial chi-square	0.0741	0.1583	0.5111	0.7408
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	20	20	20	20
Degrees of freedom	19	19	19	19
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR Ukr

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0476	0.1123	0.1295	0.4651
Skewness test stat.	1.3396	0.3398	-1.6301	-1.7528
Kurtosis test statisti	-0.2825	-0.3073	1.3567	-0.0873
Partial chi-square	0.0776	0.1952	0.2506	1.2813
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	20	20	20	20
Degrees of freedom	19	19	19	19
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR Rom survey

Linear catchability relationship assumed

Age	1	2	3
Variance	0.1322	0.0792	0.6295
Skewness test stat.	0.4427	0.7448	-1.0060
Kurtosis test statisti	-0.3312	-0.3560	-0.0686
Partial chi-square	0.0503	0.0315	0.3105
Significance in fit	0.0003	0.0001	0.0109
Number of observations	5	5	5
Degrees of freedom	4	4	4
Weight in the analysis	0.3333	0.3333	0.3333

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	116.1001	205	30	175	0.6634
Catches at age	2.2075	30	19	11	0.2007
Aged Indices					
Bul	46.4635	80	4	76	0.6114
Ukr	57.3390	80	4	76	0.7545
Rom survey	10.0902	15	3	12	0.8408

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	9.4553	205	30	175	0.0540
Catches at age	1.8465	30	19	11	0.1679
Aged Indices					
Bul	2.9040	80	4	76	0.0382
Ukr	3.5837	80	4	76	0.0472
Rom survey	1.1211	15	3	12	0.0934

6.1.5 Short term prediction of stock biomass and catch

6.1.5.1 Justification

A deterministic short term prediction of stock size and catch was conducted based on ICA results.

6.1.5.2 Input parameters

The input parameters are listed in the Table 6.1.5.2.1 below. They do represent short term averages of the ICA inputs. The exploitation pattern used is the 2014 estimated vector rescaled to the average exploitation patterns estimated for the years 2011-2013. Due to the lack of recruitment index, recruitment was estimated using the geometric mean from 2010-2012.
As the fishery for sprat in the Black Sea is not constrained by an international TAC the year 2014 was defined as a *status quo* effort year with unchanged fishing mortality.

Table 6.1.5.2.1. Sprat in the Black Sea. Input to short term prediction.

2014						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	99217596	0.6400	0.0000	0.001	0.0167	0.0018
1	51449586	0.9500	1.0000	0.0016	0.1377	0.0021
2	23416807	0.9500	1.0000	0.0041	0.3988	0.0033
3	3654545	0.9500	1.0000	0.0048	0.8008	0.005
4	319492	0.9500	1.0000	0.008	0.3988	0.0068
5	54507	0.9500	1.0000	0.01	0.3988	0.01
2015						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	99217596	0.6400	0.0000	0.001	0.0167	0.0018
1		0.9500	1.0000	0.0016	0.1377	0.0021
2		0.9500	1.0000	0.0041	0.3988	0.0033
3		0.9500	1.0000	0.0048	0.8008	0.005
4		0.9500	1.0000	0.008	0.3988	0.0068
5		0.9500	1.0000	0.01	0.3988	0.01
2016						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)

0	99217596	0.6400	0.0000	0.001	0.0167	0.0018
1		0.9500	1.0000	0.0016	0.1377	0.0021
2		0.9500	1.0000	0.0041	0.3988	0.0033
3		0.9500	1.0000	0.0048	0.8008	0.005
4		0.9500	1.0000	0.008	0.3988	0.0068
5		0.9500	1.0000	0.01	0.3988	0.01

6.1.5.3 Results

Table 6.1.5.3.1 Sprat in the Black Sea. Single option (status quo) short term prediction.

2014	F-factor:	1	reference F1-3	0.4458			1 January
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0167	1215668	2188	99217595.78	99218	0	0
1	0.1377	4319288	9071	51449585.54	82319	51449586	82319
2	0.3988	5126431	16917	23416806.6	96009	23416807	96009
3	0.8008	1381300	6907	3654545.255	17542	3654545	17542
4	0.3988	69944	476	319492.3709	2556	319492	2556
5	0.3988	11933	119	54506.7119	545	54507	545
		12124564	35678	178112532	298189	78894937	198971
2015	F-factor:	1	reference F1-3	0.4458			1 January
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0167	1215668	2188	99217596	99218	0	0
1	0.1377	4319288	9071	51449586	82319	51449586	82319
2	0.3988	3795549	12525	17337530	71084	17337530	71084
3	0.8008	2297275	11486	6077967	29174	6077967	29174
4	0.3988	138920	945	634565	5077	634565	5077
5	0.3988	18154	182	82926	829	82926	829
		11784854	36397	174800170	287701	75582574	188483
2016	F-factor:	1	reference F1-3	0.4458			1 January
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0167	1215668	2188	99217596	99218	0	0
1	0.1377	4319288	9071	51449586	82319	51449586	82319
2	0.3988	3795550	12525	17337531	71084	17337531	71084
3	0.8008	1700876	8504	4500056	21600	4500056	21600
4	0.3988	231041	1571	1055361	8443	1055361	8443
5	0.3988	36057	361	164705	1647	164705	1647
		11298480	34220	173724835	284311	74507239	185093

The *status quo* fishing in 2014 would result in landings 35 678 t and SSB of 198 971 t. At present levels of abundance and fishing mortality, the *status quo* model predicts some decrease in biomass in 2015 – 2016. Catches would slightly increase in 2015 (36 397 t) due to higher numbers of 3 years old fish (Table 6.1.5.3.1).

Recruitment estimates are rather imprecise due to the lack of survey data. Since 2011 there is an increasing trend in recruitment, which have not yet materialised in a biomass increase. In short-term forecast we used a geometric mean over 2010-2012 equal of 99 217 596.

Catches have been very high during 2009-2011 due to the rapidly expanding Turkish fishery. In 2012 the catches dropped to 35 050 t and in 2013 - to 27 260t. The largest drop in catches is due to the lower catch by the Turkish fishery (Table 6.1.2.3.1.1). Under the status quo F assumption catches are expected to increase in 2014-2015.

Given that the state of the stock depends greatly on a variable recruitment, the dynamic nature of developing Turkish sprat fishery and the lack of quota constraints on the sprat fisheries, the status quo assumption must be taken with a caution when considered in management advice.

More management options through multiplications of the fishing mortality are given in Table 6.1.5.3.2. The Fmsy level of fishing mortality of 0.64 (corresponding to exploitation rate of 0.4. Patterson 1992, Daskalov et al. 2011) would reduce forecast catches from 48 755 t in 2015 to 42 558 t in 2016. On the other hand, keeping the *status quo* F, the catch is predicted to decrease from 36 397 t in 2015 to 34 220 t in 2016.

At present the sprat stock is experiencing a downward trend from the historically high abundance peak in 2008-2009. This trend, combined with the unprecedentedly high fishing pressure during the last years, prevents the SSB to recover, in spite of the indications of improving recruitment in 2011-2012.

Table 6.1.5.3.2. Sprat in the Black Sea. Management option table providing short term prediction.

2014					2015					2016		
F-factor	reference F	stock biomass	sp. stock biomass	catch in weight	F-factor	reference F	stock biomass	sp. stock bioma	catch in weight	stock biomass	sp. stock bioma	catch
1.0000	0.4458	298189	198971	35678	0.0000	0.0000	287842	188624	0	318325	219107	0
					0.1000	0.0446	287842	188624	4272	314255	215037	4872
					0.2000	0.0892	287842	188624	8384	310365	211147	9331
					0.3000	0.1337	287842	188624	12341	306646	207428	13417
					0.4000	0.1736	287842	188624	16155	303085	203867	17163
					0.5500	0.2387	287842	188624	21620	298024	198806	22228
					0.6000	0.2604	287842	188624	23377	296406	197188	23779
					0.7000	0.3120	287842	188624	26799	293268	194050	26703
					0.8000	0.3566	287842	188624	30107	290257	191039	29404
					0.9000	0.4012	287842	188624	33305	287364	188146	31904
				Fsq	**1.0000**	**0.4458**	**287701**	**188483**	**36397**	**284311**	**185093**	**34220**
					1.1000	0.4903	287842	188624	39390	281906	182688	36371
					1.2000	0.5349	287842	188624	42288	279328	180110	38371
					1.3000	0.5795	287842	188624	45097	276845	177627	40236
					1.4000	0.6241	287842	188624	47821	274450	175232	41976
					1.5000	0.6687	287842	188624	50463	272138	172920	43603
				Fmsy	**1.435**	**0.640**	**287842**	**188624**	**48755**	**273631**	**174413**	**42558**

6.1.6 Medium term prediction of stock biomass and catch

The EWG did not undertake medium term projections

6.1.7 Long term predictions

Fmax could not be estimated due to shape to the YpR curve, which has a maximum well outside of the reasonable range. The skewed shape of the YpR curve results from the high natural mortality and the short life span of sprat in the Black Sea. Due to such effects STECF EWG 14-14 on Black Sea does not consider $F_{0.1}$ as an appropriate management reference point and proposes a limit reference point of exploitation rate E≤0.4 which implies Fmsy = 0.64.

6.1.8 Scientific advice

6.1.8.1 Short term considerations

The EWG accepted the current ICA assessment as adequately presenting the state and dynamics of the stock and the development of the fisheries.

State of the spawning stock size: According to the present assessment in recent years the SSB is at medium levels (180 000-300 000 t) with a decreasing trend since 2010. In 2013, SSB has dropped to 179 464 t. Under a constant recruitment scenario and status quo F = 0.446, in 2014 SSB is expected to increase to 198 189 t and after to decrease again to 185 093 t by 2016.

State of recruitment: Recruitment reached a low in 2010-2011 and since then started to increase. Recruitment estimates are rather imprecise due to the lack of survey data. In short-term forecast we used a geometric mean over 2010-2012 average value of 99 217 596.

State of exploitation: Over the last few years the fishing mortality has peaked in 2010-2012 at a level of 0.7 - 1.24. Proposing a limit reference point of exploitation rate E≤0.4 that equals F = 0.64 (as suggested by Patterson 1992 for short living fish), the EWG considers that the catches where too high over 2010-2012, that supported the decreasing trend in SSB. The current (2013) F=0.446 has resulted from an about 4 times drop in total catches since 2011 when the catches peaked at 120 710t. *Status quo* fishing implies catches in the range of 36 397 - 34 200 t over 2014 - 2016 which are bellow the recommended catch of 48 755 t, at Fmsy.

6.1.8.2 Medium term considerations

Due to the cyclic nature of recruitment and unknown dependence on environmental conditions the EWG is not able to provide medium term forecast. The record catches over 2009-2011 seemed of being sustained by some of the highest historically recorded levels of recruitment (over 2007-2009), but reversed trend in recruitment over 2010-2011 and no indications of recovery of the SSB should warn against further expansion of the sprat fisheries over the next years.

6.2 TURBOT IN GSA 29

6.2.1 Biological features

Turbot (*Psetta maxima/Scophthalmus maximus*) is a demersal species, inhabiting the shelf area of all Black Sea countries at depths up to 100 m -140 m. Species occur in different habitats, including sandy and silty bottoms and mussel beds. The reproduction process occurs during the spring season – between April and June. Turbot in the Black Sea is represented by several local populations, which migrate and mix in the adjacent zones. Local populations are independent units of the stock, and have to be covered in order to ensure an accurate assessment of the stock at regional level. The gaps in available information regarding distribution of different stock unit, accurate fisheries statistics, estimates of discards and by-catch, availability of biological data and share of IUU fisheries continue to exist.

The taxonomic status of Black Sea turbot as a subspecies has not been clarified yet. It is still being argued whether this fish distributed in different locations of Black Sea is the same species or there is a subspecies. Popova (1954) and Karpetkova (1964) recorded that the turbot forms mixed local populations in nearby zones which is proved by tagging experiments. However, the suggestion for the presence of local varieties of turbot (ecotypes) currently exists. The analysis of the haplotype sequences data did not provide clear indications on the existence of phylogeographic differentiation among the studied turbot populations inhabiting the west coast of the Black Sea. At the same time the haplotype phylogenetic analysis provided further support to the earlier proposed existence of two distinct turbot mitochondrial lineages, 'western Mediterranean' and 'eastern secluded Mediterranean basins'. The present study offers an essential background for long term monitoring of the changes of the Black Sea turbot populations (Atanassov, et al. 2011). Turbot is represented by several local populations mixing in the adjacent zones in the Black Sea. It is also to be found in the Black Sea, where (sub) species *Psetta maxima maeotica* has been described (Suzuki et al. 2004). Local populations are independent units of the stock, and it is especially important to cover them all in order to provide an accurate assessment of the stock (Daskalov et al., 2010).

6.2.1.1 Stock structure assumed in the assessment

The present assessment is based on the analysis of the best available information, obtained from combined data of all Black Sea countries and assuming the stock as representing a single unit in the entire Black Sea.

6.2.1.2 Growth

The parameters reported by countries are considered appropriate for the description of an average growth performance of the species in GSA 29 – Tab. 6.2.1.2.1.

Table 6.2.1.2.1. Growth parameters of turbot by countries and periods.

COUNTRY	AREA	YEAR_PERIOD	SPECIES	SEX	L_INF	K	t_0	a	b
ROM	29	2003-2005	TUR	C	80.98	0.15	-1.37	0.000018	3.01
ROM	29	2006-2008	TUR	C	72.5	0.212	-1.15	0.00806	3.22
ROM	29	2009-2011	TUR	C	86.3	0.19	-2.1	0.030088	2.87
BGR	29	2007-2008	TUR	C	77.81	0.242	0.152	0.000431	2.21
BGR	29	2008-2009	TUR	C	120.4	0.076	-2.811	0.000011	3.13
BGR	29	2008-2009	TUR	F	129.81	0.065	-3.351	0.000013	3.11
BGR	29	2008-2009	TUR	M	67.38	0.246	-1.217	0.000041	2.78
BGR	29	2007-2008	TUR	M	57.6	0.507	0.458	0.000918	1.96
BGR	29	2007-2008	TUR	F	80.31	0.213	-0.136	0.000424	2.22

BGR	29	2006-2007	TUR	M	77.49	0.158	-1.975	0.000022	2.92
BGR	29	2006-2007	TUR	F	124.27	0.08	-2.136	0.000021	2.94
BGR	29	2006-2007	TUR	C	79.26	0.173	-1.561	0.000008	3.17
UKR (NE)	29	2000 - 2006	TUR	C				0.000216	2.48
UKR (NW)	29	2008 - 2009	TUR	C	74	0.106	-1.73	0.001437	1.94
TR	29	1990 - 1991	TUR	C	82.57	0.17	-0.93	0.0085	3.18
TR	29	1990 - 1996	TUR	C	96.24	0.119	-0.01	0.0112	3.12
TR	29	1998 - 2000	TUR	C	95.9	0.104	-1.55	0.0106	3.14
BGR-RO	29	2010	TUR	M	73.36	0.194	-1.779	0.00004	2.799
BGR-RO	29	2010	TUR	F	113.553	0.089	-2.489	0.0000007	3.795
TR	29	2010	TUR	C	60.57	0.218	0.25	0.12	3.081
BGR	29	2011	TUR	C	69.98	0.395	1.043	0.000033887	2.837
TR(west)	29	2011	TUR	C	96.376	0.112	-1.304	0.014	3.059
TR(east)	29	2011	TUR	C	101.12	0.11	-1.24	0.01	3.17
RO	29	2011	TUR	C	86.32	0.24	-1.97	0.06	2.66
BGR	29	2012	TUR	C	88.44	0.17	-0.34	0.00	2.86
RO	29	2012	TUR	C	86.32	0.22	-0.49	0.04	2.84
TR	29	2012	TUR	C	82.41	0.34	-3.73	0.01	3.09
BG	29	2013	TUR	C	97.21	0.14	-0.61	0.00	2.58
TR	29	2013	TUR	C	85.96	0.14	-1.15	0.01	3.07
RO	29	2013	TUR	C	76.84	0.39	-0.48	0.01	3.15

6.2.1.3 Maturity

The maturity ogive for 2013 was prepared based on data collected during surveys (DCF, from commercial fisheries, national monitoring programs, etc.) from Bulgaria, Romania and Turkey, averaged by age groups. The proportions of mature individuals by age groups for the period 1970 – 2013 are given in Table 6.2.1.3.1. Maturity ogives were calculated as the average for the period 2007 – 2009 due to good data consistency for these years and applied over the whole time series.

Table 6.2.1.3.1. Common maturity ogive of turbot by ages and years.

Year/Age	1	2	3	4	5	6	7	8	9	10+
1970-2006	0	0	0.75	1	1	1	1	1	1	1
2007	0	0	0.38	0.61	1	1	1	1	1	1
2008	0	0	0.51	0.76	1	1	1	1	1	1
2009	0	0	0.41	0.67	1	1	1	1	1	1
2010	0	0	0.22	0.83	1	1	1	1	1	1
2011	0	0.06	0.20	0.86	1	1	1	1	1	1
2012	0	0.13	0.52	0.92	1	1	1	1	1	1
2013	0	0.036	0.686	0.93	1	1	1	1	1	0

6.2.2 Fisheries

6.2.2.1 General Description

The Black Sea turbot (*Psetta maxima/Scophthalmus maximus*) historically has been fished by all coastal states, using both stationary and mobile fishing gears (gillnets and bottom trawls). The species is often caught as a by-catch of otter trawls, long lines and purse seiners fishery. Total annual landings in the Black Sea present a decreasing trend during the last years - from 1035 t in 2007 to 500 t in 2013. IUU fisheries on turbot also occur.

6.2.2.2 Management regulations applicable in 2012 and 2013

Turbot fisheries in Black Sea EU waters are being managed through the annual establishment of fishing opportunities (EU quotas) since 2008, by the adoption of Council Regulations. During the last four years, the EU turbot quota has been fixed at 86.4 t and equally allocated to Bulgaria and Romania (50 % each). The same Council Regulations set up every year the prohibition of fishing activities during reproduction period for turbot. The ban has been in force from 15 April to 15 June in European Community waters of the Black Sea. The same period of prohibition is fixed by Turkish National Legislation.

During the 37th Session of the General Fisheries Commission for the Mediterranean (GFCM), a recommendation to establish a set of minimum standards for Turbot fisheries in the Black Sea was adopted. This recommendation, set up minimum conservation size (45 cm) for turbot and minimum mesh size (400 mm) for gillnets. Proposed measures were already in place in Turkey and the EU.

In Turkey, turbot fisheries have been traditionally conducted by bottom set gill nets with minimum mesh size of 320-400 mm (Tonay, Öztürk, 2003) and by bottom trawls - with minimum mesh size 40 mm. However the above mentioned GFCM recommendation establishes gillnets as the only gear allowed to fish turbot in the Black Sea.

Though some violations, turbot fishery is conducted along offshore waters starting from 3 miles from coast to 9.7 miles. Fishing depth ranges between 25 m and 100 m. The catches are highest within depths of 50-60 m. The basic management criteria for turbot fisheries in 2012-2014 announced by Commercial Fishery Advice of General Directorate of Fishery in Turkey are summarized below:

- Area closures: Bottom trawling is prohibited in the areas between 1) Sinop city, İnceburun (42° 05.959’ N-34° 56.695’E and Samsun city Çayağzı cape (41° 41.040’ N-35° 25.193’ E), 2) Ordu city; Ünye, Taşkana cape (41° 08.725’ N-37° 17.531’ 4) and Georgia border. Furthermore, it is also banned within 2 miles from land between Zonguldak city; Ereğli, Baba cape (41° 17.342’ N-31° 23.937’E) and Bartın city; Amasra, Tekke cape (41° 43.485' N-32° 19.258' E) (Fig.6.2.2.2.1). In the rest of the areas, the waters open for trawling are 3 miles from the coast.

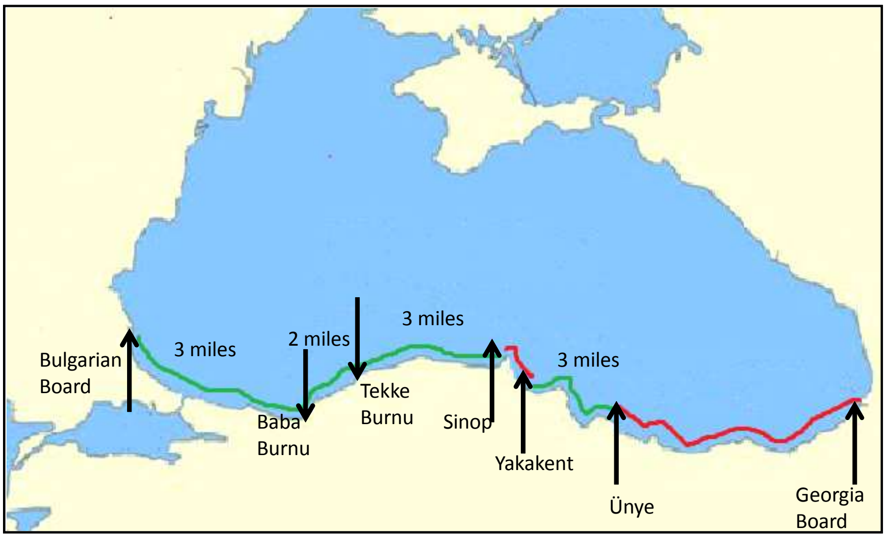


Fig. 6.2.2.2.1. Area closures and distance limitations for bottom trawling along theTurkish coast (Green lines: open areas, red lines: area closures).

- Time closures: In open areas, bottom trawling for turbot is banned between 15 April and 15 September. Turbot fishery by gillnet is allowed except during the period 15 April – 15 June.

- Mesh size limitations: a) Mesh size of the codend should not be lower than 40 mm for bottom trawl nets. b) Mesh size of gillnets should not be lower than 400 mm. c) Long lines and trammel gillnets are forbidden for turbot fishery.
- Minimum legal catch size: Minimum legal size (total length) is determined as 45 cm for all fishing gears.

In Ukraine turbot fisheries are conducted with bottom (turbot) gill nets with mesh size 360 - 400 mm. The use of bottom trawls has been prohibited. Turbot exploitation in Ukraine has been regulated by TACs since 1996.The Ukranian TAC for turbot in 2012 was 430 tons.

The Regulations of Fisheries in Ukraine determine the following standards regulating the fisheries of the Black Sea turbot:

- minimum commercial fishing size – 35 cm (SL);
- allowable by-catch of juveniles – for the non-target fisheries not more than 2% of total catch weight; for the target fisheries with nets (with mesh size 360 mm) not more than 5% in numbers;
- during target long-lining of picked dogfish and Rajiformes by-catch of turbots is allowed, at the amount of not more than 20% of juveniles in numbers;
- turbot by-catch is allowed in trawl catches of sprat not more than 4 individuals of commercial fishing length per one ton of catch;
- in the period of abundant spawning of turbot in the coastal 12-mile zone a temporal prohibition for 15 – 30 days is implemented for harvesting of fish with trawls, net and long-lines (such prohibition applies to different zones at different periods depending on the maturity of fish).

There is a full ban on the use of bottom trawls in Ukraine and fishery ban on the use of gillnets for turbot during the period from 1 November to 31 January. Additionally, in the economic zone beyond the territorial waters a ban on the use of gillnets and by-catch in other gears is in place during the spawning period from 1 to 30 May. In the same month, a ban on the fishing of turbot in the territorial waters of Ukraine, which has a duration of 15 days is implemented. The initial term of this period is set according to the recommendations of the scientific institute that monitors the state of maturity of the fish.

The fishing effort on turbot is limited to 7,700 gillnets (100 m each). For small vessels the minimum number of gillnets is 20. For registered vessels are 100 units.

6.2.2.3 Catches

6.2.2.3.1 Landings

Landings data for Bulgaria and Romania were reported to the STECF EWG 14 14 through the EU Data collection program and for Turkey, Ukraine and Russia – according to the official statistics of each country. Since 2002 total annual landings varied between 424 and 1035 tons (Tab. 6.2.2.3.1.1). The data set of landings by countries was compiled for the period 1989 – 2013 with the estimates of IUU landings added.

Table 6.2.2.3.1.1 Landings and landings with the IUU estimates of turbot in the Black Sea during the period 1989 – 2013.

Year	Bulgaria	Romania	Ukraine west	Ukraine east	Turkey west	Turkey east	Russia	Georgia	Total Black Sea	Total BS with IUU
1989	0.9	0	2	0	448	1001	0	8	1459.9	
1990	0	0	9	0	908	475	0	1	1393	
1991	0	2	17.1	0.9	600	315	0	0	935	
1992	0	1	18	1	308	110	1	0	439	
1993	0	6	10	0	400	1185	2	0	1603	
1994	0	6	18	1	1293	821	5	0	2144	
1995	60	4	10	0	2006	844	19	0	2943	
1996	62	6	37	2	1414	510	17	0	2048	
1997	60	1	40	2	777	134	11	0	1025	
1998	64	0	40	2	1056	412	14	0	1588	
1999	54	2	69	4	1579	225	15	5	1953	
2000	55.1	2	76	4	2321	318	4	9	2789.1	
2001	56.5	13	123	6	2169	154	24	11	2556.5	
2002	135.5	16.68	99	5.47	193	142	15	11	617.651	1567.3
2003	40.8	23.98	118	5.876	126	93	15	1	423.654	1121.7
2004	16.2	42.03	126	7.157	118	116	1.7	7	434.088	1142.2
2005	12.69	36.53	123	6	273	275	7.5	7	740.72	1400.1
2006	14.81	35.11	154	8	266	481	7.6	0	966.52	1750.6
2007	66.85	48.06	205	10.58	346	353	5.7	0	1035.4	2259.0
2008	54.62	47.11	239	12.35	224	234	4.7	0	815.79	2122.2
2009	52.47	48.77	247	16	223	119	24.3	0	730.54	2078.2
2010	46.45	48.25	166	41	218	77	25	0	621.7	1738.0
2011	37.8	43.25	211	25	108.1	36.4	24.09	0	485.64	1658.7
2012	36.38	43.213	223.03	17.91	172.2	0	35.27	0	527.99	1713.9
2013	39.58	43.2	181.03	12.34	118.6	75	30	0	499.76	1521.53

6.2.2.3.2 Discards

No data for turbot discards have been reported to STECF EWG 14 14 Black Sea assessments. However, the discards for the gillnets fishery are considered to be negligible for turbot in the Black Sea due to selectivity of the gear (400 mm). But the turbot is by-catched in otter trawl, long lines and beam trawl fishery due to low selectivity of the gears. The by-catch of other non-target species (*R.clavata, Sq.acanthias, Acipenser* spp., cetacean) in turbot fishing gear could be significant.

6.2.2.4 Fishing effort

Total fishing effort data for Bulgaria and Romania (Table 6.2.2.4.1 and Table 6.2.2.4.2) were reported to EWG 14 14 through the Data collection program (DCF).

Table 6.2.2.4.1 DCF total fishing effort data (kW days at sea) by gear of Bulgaria during 2008 - 2013.

Country	Year	Vessel length	Gear	Mesh size range	Fishery	Nominal effort	GT Days at sea	No vessels
BUL	2008	VL0006	SB	00D14	MDPSP	86279	7201	45
BUL	2008	VL0612	GNS	400DXX	MDPSP	13360571	1199491	244
BUL	2008	VL0612	FPO	00D14	MDPSP	16388855	155008	192

Country	Year	Vessel	Gear	Mesh size	Fishery	Nominal	GT Days	No
BUL	2008	VL1218	GNS	400DXX	MDPSP	538247	81346	11
BUL	2008	VL1218	OTM	00D14	SPF	1068620	146035	9
BUL	2008	VL1218	LLD	400DXX	MDPSP	1583816	218369	24
BUL	2008	VL1824	OTM	00D14	SPF	808959	204422	4
BUL	2008	VL1824	GNS	400DXX	MDPSP	514801	111688	9
BUL	2008	VL2440	OTM	20D40	SPF	4251250	2025889	11
BUL	2009	VL0006	GNS	400DXX	MDPSP	4397290	437650	246
BUL	2009	VL0006	SB	00D14	MDPSP	35948	6960	38
BUL	2009	VL0612	GNS	400DXX	MDPSP	31677082	2666531	376
BUL	2009	VL0612	FPO	00D14	MDPSP	12075037	1178437	169
BUL	2009	VL1218	GNS	400DXX	MDPSP	904853	133394	3
BUL	2009	VL1218	LLD	400DXX	MDPSP	2589388	346649	27
BUL	2009	VL1218	OTM	00D14	SPF	2957668	434558	15
BUL	2009	VL1824	OTM	00D14	SPF	1440379	376387	5
BUL	2009	VL1824	GNS	400DXX	MDPSP	663300	170129	11
BUL	2009	VL2440	OTM	20D40	SPF	5520149	2650975	12
BUL	2010	VL0006	GNS	400DXX	MDPSP	6035886	628691	290
BUL	2010	VL0006	SB	00D14	MDPSP	249121	27299	64
BUL	2010	VL0612	GNS	400DXX	MDPSP	48632062	3937369	408
BUL	2010	VL0612	FPO	00D14	MDPSP	18617358	1710535	188
BUL	2010	VL1218	GNS	400DXX	MDPSP	811362	112706	7
BUL	2010	VL1218	OTM	00D14	SPF	3559407	449947	6
BUL	2010	VL1218	LLD	400DXX	MDPSP	6027502	812014	37
BUL	2010	VL1824	OTM	00D14	SPF	1306384	351630	7
BUL	2010	VL1824	GNS	400DXX	MDPSP	632845	178907	10
BUL	2010	VL2440	OTM	20D40	SPF	6995010	3003786	13
BUL	2011	VL0006	GNS	400DXX	MDPSP	9494891	971580	302
BUL	2011	VL0006	SB	00D14	MDPSP	34136	3493	39
BUL	2011	VL0612	GNS	400DXX	MDPSP	83113602	7195983	498
BUL	2011	VL0612	FPO	00D14	MDPSP	740804	64139	87
BUL	2011	VL0612	OTM	00D14	MDPSP	180869	15660	4
BUL	2011	VL1218	GNS	400DXX	MDPSP	1133407	160684	36
BUL	2011	VL1218	OTM	00D14	SPF	5833424	827010	23
BUL	2011	VL1218	LLD	400DXX	MDPSP	679442	96325	1
BUL	2011	VL1824	GNS	400DXX	SPF	147305	42327	6
BUL	2011	VL1824	LLS	400DXX	MDPSP	36536	10498	1
BUL	2011	VL1824	OTM	00D14	MDPSP	856319	246060	5
BUL	2011	VL2440	OTM	20D40	SPF	6172300	2718507	11
BUL	2011	VL2440	GNS	400DXX	MDPSP	541	238	1
BUL	2011	VL2440	GNS	400DXX	MDPSP	541	238	1
BUL	2012	VL0006	GNS	400DXX	MDPSP	5426700	513205	225
BUL	2012	VL0006	SB	00D14	MDPSP	1649473	156317	124
BUL	2012	VL0612	GNS	400DXX	MDPSP	65359376	5419588	389
BUL	2012	VL0612	FPO	00D14	MDPSP	4694659	389268	104
BUL	2012	VL0612	OTM	00D14	MDPSP	26822	2224	8
BUL	2012	VL1218	GNS	400DXX	MDPSP	2248723	300324	14
BUL	2012	VL1218	OTM	00D14	SPF	7499190	1001555	26
BUL	2012	VL1218	LLD	400DXX	MDPSP	85823	11462	3
BUL	2012	VL1824	GNS	400DXX	SPF	355986	92488	4

Country	Year	Vessel	Gear	Mesh size	Fishery	Nominal	GT Days	No
BUL	2012	VL1824	OTM	00D14	MDPSP	2080654	543064	12
BUL	2012	VL2440	OTM	20D40	SPF	5570111	2511970	10
BUL	2012	VL2440	GNS	400DXX	MDPSP	0	0	0
BUL	2013	VL0006	GNS	400DXX	MDPSP	7041	360	133
BUL	2013	VL0612	GNS	400DXX	MDPSP	54166	5150	267
BUL	2013	VL1218	GNS	400DXX	MDPSP	133344.19	18304.06	45
BUL	2013	VL1824	GNS	400DXX	MDPSP	61155.05	13155.2	10
BUL	2013	VL2440	GNS	400DXX	MDPSP	20776.55	3633.62	5
BUL	2013	VL0006	SB	00D14	MDPSP	484.69	145.81	16
BUL	2013	VL0612	SB	00D14	MDPSP	535.56	78.98	10
BUL	2013	VL0006	FPO	00D14	SPF	295.47	54.27	1
BUL	2013	VL0612	FPO	00D14	SPF	22012.69	2297.76	31
BUL	2013	VL0612	OTM	00D14	MDPSP	10819.3	1204.68	10
BUL	2013	VL1218	OTM	00D14	MDPSP	193288.78	22383.52	35
BUL	2013	VL1824	OTM	00D14	MDPSP	135303.21	38066.14	13
BUL	2013	VL2440	OTM	20D40	MDPSP	430653.55	207801.25	11
BUL	2013	VL0006	LLD		DEMF	44.11	8.29	2
BUL	2013	VL0612	LLD		DEMF	4730.35	455.61	7
BUL	2013	VL1218	LLD		DEMF	16172.28	2234.18	15
BUL	2013	VL1824	LLD		DEMF	4209.56	655	2
BUL	2013	VL0006	LLS		DEMF	496.58	30.96	3
BUL	2013	VL0612	LLS		DEMF	6870.9	655.53	11
BUL	2013	VL1218	LLS		DEMF	993.61	117.48	2
BUL	2013	VL1824	LLS		DEMF	7919.2	1382.75	5

In Bulgaria, the total number of approved vessels involved in the turbot fishery in 2013 was reduced to 124, which is more than 3 times lower compared to 2012 due to introduction of new system for distribution of national quota between vessels.

Table 6.2.2.4.2. DCF total fishing effort data (kW days at sea) by gear of Romania during 2008 - 2013.

Country	Year	Vessel length	Gear	Mesh size range	Fishery	Nominal effort	GT Days at sea	No vessels
ROM	2008	VL2440	GNS	400DXX	DEMF	63552	26112	4
ROM	2008	VL2440	OTM	14D16	MDPSP	193304	79424	4
ROM	2008	VL1224	GNS	100D400	DEMF	1404	453	2
ROM	2008	VL1824	GNS	400DXX	DEMF	11040	3400	2
ROM	2008	VL1824	OTM	14D16	MDPSP	16560	5100	2
ROM	2008	VL1218	GNS	400DXX	DEMF	11520	1277	4
ROM	2008	VL1218	OTM	14D16	MDPSP	2740	304	4
ROM	2008	VL0612	FPN	14D16	MDPSP	72575	32256	13
ROM	2008	VL0006	GNS	400DXX	DEMF	8031	305	12
ROM	2008	VL0612	GNS	400DXX	DEMF	1728872	146614	68
ROM	2008	VL0006	GNS	100D400	DEMF	8700	332	3
ROM	2008	VL0006	FPN	14D16	MDPSP	3198	410	4
ROM	2009	VL2440	OTM	14D16	SPF	10592	4352	2
ROM	2009	VL2440	GNS	400DXX	DEMF	4965	2040	1
ROM	2009	VL2440	GNS	100D400	DEMF	331	136	1
ROM	2008	VL0612	GNS	100D400	DEMF	1414531	119957	37

Country	Year	Vessel	Gear	Mesh size	Fishery	Nominal	GT Days at	No
ROM	2009	VL1824	GNS	400DXX	DEMF	2429	517	1
ROM	2009	VL1824	GNS	100D400	DEMF	221	47	1
ROM	2009	VL1218	GNS	400DXX	DEMF	7801	866	3
ROM	2009	VL0612	GNS	400DXX	DEMF	3611961	306351	100
ROM	2009	VL0612	GNS	100D400	DEMF	306351	30299	36
ROM	2009	VL0612	FPN	14D16	MDPSP	113342	50377	17
ROM	2009	VL0006	GNS	400DXX	DEMF	6033	225	9
ROM	2009	VL0006	GNS	100D400	DEMF	983	42	3
ROM	2009	VL0006	FPN	14D16	MDPSP	5429	714	7
ROM	2010	VL2440	OTM	14D16	SPF	662	272	1
ROM	2010	VL0612	GNS	400DXX	DEMF	3383293	306344	124
ROM	2010	VL0612	GNS	100D400	DEMF	254657	23059	27
ROM	2010	VL0612	FPN	14D16	MDPSP	102528	45546	14
ROM	2010	VL0612	none	none	DEMSP	810	57	3
ROM	2010	VL0006	GNS	400DXX	DEMF	2519	323	3
ROM	2010	VL0006	FPN	14D16	MDPSP	2624	100	3
ROM	2011	VL2440	GNS	400DXX	DEMF	2208	645	1
ROM	2011	VL2440	OTM	14D16	SPF	27158	8012	2
ROM	2011	VL2440	OTM	14D16	MDPSP	4416	1290	1
ROM	2011	VL1824	GNS	400DXX	DEMF	3641	965	1
ROM	2011	VL1824	GNS	100D400	DEMF	1324	351	1
ROM	2011	VL0612	LLS	none	DEMF	7137	622	4
ROM	2011	VL0612	GNS	400DXX	DEMF	4190670	154361	49
ROM	2011	VL0612	GNS	100D400	DEMF	8429	405	8
ROM	2011	VL0612	none	none	DEMSP	80851	1261	3
ROM	2011	VL0612	FPN	14D16	MDPSP	90236	26371	40
ROM	2011	VL0006	GNS	400DXX	DEMF	14039	558	6
ROM	2011	VL0006	GNS	100D400	DEMF	143	8	1
ROM	2011	VL0006	FPN	14D16	MDPSP	1727	151	8
ROM	2011	VL0006	none	none	DEMSP	777	84	3
ROM	2012	VL2440	OTM	14D16	SPF	23405	6837	1
ROM	2012	VL2440	GNS	400DXX	DEMF	5299	1548	1
ROM	2012	VL2440			DEMSP	883	258	1
ROM	2012	VL1824	GNS	400DXX	DEMF	3641	963	1
ROM	2012	VL1824	GNS	100D400	DEMF	993	263	1
ROM	2012	VL1218	GNS	400DXX	DEMF	5556	544	2
ROM	2012	VL1218	GNS	100D400	DEMF	926	91	2
ROM	2012	VL1218	FPN	14D16	MDPSP	695	68	1
ROM	2012	VL0612	GNS	400DXX	DEMF	633607	26041	55
ROM	2012	VL0612	GNS	100D400	DEMF	2088	114	7
ROM	2012	VL0612	LLS		DEMF	1375	102	2
ROM	2012	VL0612	FPN	14D16	MDPSP	195992	52100	27
ROM	2012	VL0612			DEMSP	418135	59769	19
ROM	2012	VL0006	GNS	400DXX	DEMF	5705	108	8
ROM	2012	VL0006	FPN	14D16	MDPSP	2394	199	4
ROM	2012	VL0006			DEMSP	1956	163	3
ROM	2013	VL2440	OTM	14D16	SPF	52245	11280	2
ROM	2013	VL2440	GNS	400DXX	DEMF	30714	1503	2
ROM	2013	VL2440	TBB	50D100	DEMSP	136727	29520	2

Country	Year	Vessel	Gear	Mesh size	Fishery	Nominal	GT Days at	No
ROM	2013	VL1218	OTM	14D16	SPF	3530	384	1
ROM	2013	VL1218	GNS	400DXX	DEMF	22448	2592	4
ROM	2013	VL1218	TBB	50D100	DEMSP	101504	11721	4
ROM	2013	VL0612	GNS	400DXX	DEMF	533918	18550	64
ROM	2013	VL0612	GNS	100D400	DEMF	220	11	1
ROM	2013	VL0612	FPN	14D16	MDPSP	195548	38434	22
ROM	2013	VL0612	LHP		SPF	150	74	4
ROM	2013	VL0612	LLS		DEMF	352	24	1
ROM	2013	VL0612	OTM	14D16	SPF	528	37	1
ROM	2013	VL0612	SB	14D16	SPF	1.212	24	2
ROM	2013	VL0612	TBB	50D100	DEMSP	452385	24978	21
ROM	2013	VL0006	GNS	400DXX	DEMF	3095	70	6
ROM	2013	VL0006	FPN	14D16	MDPSP	3270	431	4
ROM	2013	VL0006	LHP		SPF	9	1	1
ROM	2013	VL0006	TBB	50D100	DEMSP	28843	1804	4

No data were available for fishing effort and CPUE from Ukraine.

The number of fishing vessels, operating in Turkish Black Sea area on turbot fisheries are given in Table 6.2.2.4.3.

Table 6.2.2.4.3. Number of Turkish fishing vessels, operating on turbot fisheries in the Black Sea area.

Year	Vessels (in Nbs)	Year	Vessels (in Nbs)
1987	102	**2001**	286
1988	89	**2002**	300
1989	96	**2003**	133
1990	223	**2004**	141
1991	94	**2005**	212
1992	273	**2006**	231
1993	286	**2007**	206
1994	204	**2008**	263
1995	166	**2009**	237
1996	298	**2010**	225
1997	266	**2011**	298
1998	264	**2012**	362
1999	338	**2013**	486
2000	340		

6.2.2.5 Commercial CPUE

Bulgaria reported trough DCF the CPUE data for 2013, dedicated to the gillnets fisheries with mesh size of 400 mm, specialized for turbot fisheries (Tabl. 6.2.2.5.1). In 2013, turbot quota, dedicated for Bulgaria was split between 124 fishing vessels according to Order of Director of National Agency of Fisheries and Aquaculture from 28.12.2012.

Table 6.2.2.5.1. CPUE data for Bulgaria in 2013.

COUNTRY	YEAR	VESSEL_LENGHT	GEAR	MESH_SIZE_RANGE	FISHERY	NOMINAL_EFFORT	GT_DAYS_AT_SEA	NO_VESSELS
BUL	2013	VL0006	GNS	400DXX	MDPSP	7041	360	133
BUL	2013	VL0612	GNS	400DXX	MDPSP	54166	5150	267
BUL	2013	VL1218	GNS	400DXX	MDPSP	133344.19	18304.06	45
BUL	2013	VL1824	GNS	400DXX	MDPSP	61155.05	13155.2	10
BUL	2013	VL2440	GNS	400DXX	MDPSP	20776.55	3633.62	5

CPUE data for Romanian area is given on Table 6.2.2.5.2. The increase of 15% in number of vessels and 50% of days at sea is observed, compared to 2012 (Sampson et.al., 2013).

Table 6.2.2.5.2. CPUE data for Romania in 2013.

Gear	No.vessels	Landings, t	No. gillnets	Days fishing
LOA > 0 < 6	6	1620	120	132
LOA => 6<12	64	25420	1444	1938
LOA => 12<18	4	7481	400	280
LOA => 18<24	0	0	0	0
LOA => 24<40	2	8692	300	21
Total	**76**	**73213**	**2264**	**2371**

The number of fishing vessels, working on turbot fisheries in EU waters in 2013 is presented on Fig. 6.2.2.5.1.

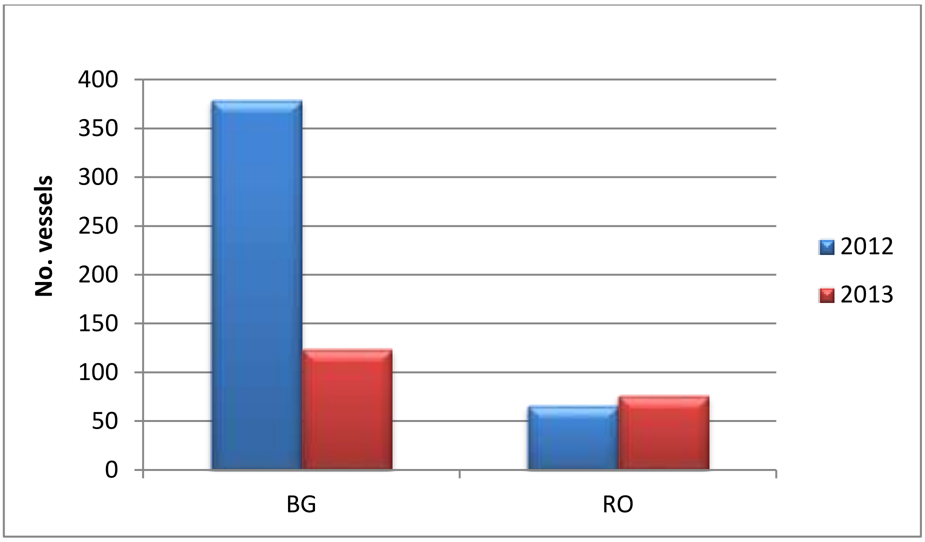


Figure 6.2.2.5.1. Number of fishing vessels in EU, operating on turbot fisheries during 2012 – 2013.

The estimates of Turkish CPUE data were based on the case study survey (KARTRİP: Back Sea Trawl Fisheries) only on turbot trawl fisheries. The total number of active vessels was 486 in 2013, from which 154 operated in Samsun Shelf Area/SSA and 332 – in West Turkish Black Sea. The data are presented on Table 6.2.2.5.3 and Fig. 6.2.2.5.2.

Table 6.2.2.5.3. Turkish CPUE data ($kg.h^{-1}$) for turbot in 2013.

Month	CPUE ($kg.h^{-1}$)
January	0.59
February	0.68
March	0.78
April	0.78
May	
June	
July	
August	
September	1.17
October	0.74
November	0.84
December	0.87

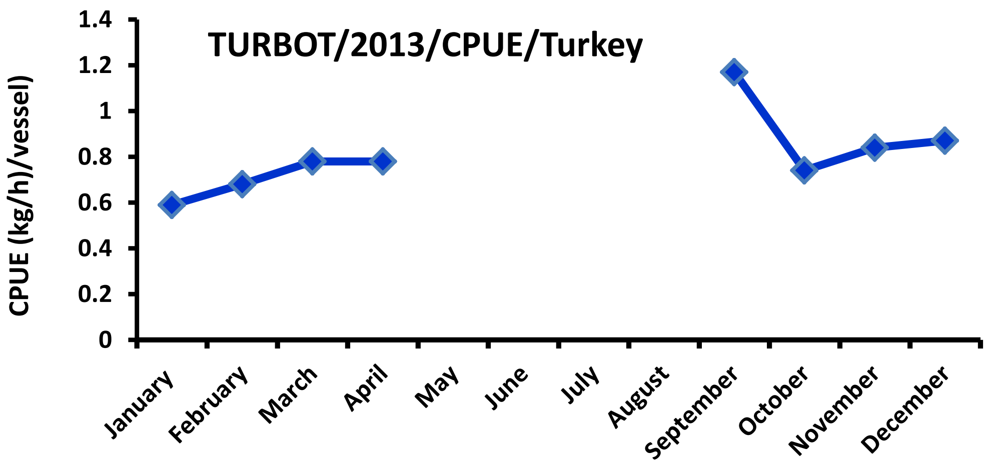


Figure 6.2.2.5.2. Monthly average CPUE data ($kg.h^{-1}$) for commercial trawl fishery in the Turkish Black Sea area in 2013.

6.2.3 Scientific surveys

6.2.3.1 Method 1 Bottom trawl survey in EU waters

Two demersal trawl surveys in EU waters (Romania) were executed under the national Data collection program of Romania in 2013. No surveys were executed in Bulgarian Black Sea area. Surveys were aimed to assess the turbot abundance and biomass indices during the spring and autumn seasons in 2013.

Standard methodology for stratified random sampling (Sparre, Venema, 1998) and swept area method were applied. The method is based on bottom trawling across the seafloor (area swept) and is widely used as a direct method for demersal fish stock assessment when only an index of abundance is required. The total number of hauls in 2013, are given on Table 6.2.3.1.1.

Table 6.2.3.1.1. Number of hauls per depth stratum of Romania in 2013.

Country	Period	Stratum	Number of hauls
RO	May - June	0 - 35 m	9
		35 - 50 m	12
		50 - 75 m	18
		75 - 100 m	2
	October	0 - 35 m	8
		35 - 50 m	19
		50 - 75 m	13

6.2.3.1.1 Geographical distribution patterns

During the research survey in spring season, the turbot population was distributed almost over the entire Romanian continental shelf between St. Gheorghe and Vama Veche. The analysis of data reveals a low average turbot catch between 0 – 0.42 t.Nm^{-2}. During the 41 hauls covering the area of 3300 Nm^2; the lowest values were recorded in the shallower areas between Cap Midia – Cap Tuzla (depth 0 -30 m / 0.08 – 0.42 t.Nm^{-2} and depth 30-50 m/0.00 – 0.189 t.Nm^{-2}) and the highest in Constanta – Sf. Gheorghe areas (depth 30-75 m/0.0 - 0.333 t.Nm^{-2}). Estimated biomass of turbot agglomerations in the surveyed area was around 130.75 t and the total estimation over the Romanian platform up to distance of 50 Mm, was about 198.109 t (Table 6.2.3.1.1.1, Fig. 6.2.3.1.1.1).

Table 6.2.3.1.1.1 Assessment of turbot agglomerations in t May 2013, demersal trawl survey , Romanian area.

Depth range (m)	0 - 30m	30 – 50m	50-70 m	70-100m	Total
Investigated area (Nm^2)	650	1225	1350	50	**3300**
Variation of the catches (t/ Nm^2)	0.08-0.42	0.00-0.189	0.00-0.333	0.00-0.330	**0.00-0.42**
Average catch (t/ Nm^2)	0.02266	0.026278	0.041944	0.164825	**0.039621**
Biomass of the fishing agglomerations (t)	14.7333	32.19028	56.625	12.3619	**130.7520**
Biomass extrapolated the Romanian shelf (t)					**198.109**

During the autumn season of 2013, 40 demersal trawling tows were conducted covering an area of 2150 Nm^2 and depth range between 20 m and 65 m. The average values of turbot catches varied between 0 and 0.60 t/Nm^{-2}. During the autumn survey, turbot had a flat distribution in the large area between Mangalia and Sulina with the higher density in Vama Veche - Constanta and Vadu - St. Gheorghe – Sulina. Estimated biomass of turbot agglomerations in the investigated area was about 237.96 t, and the total estimated biomass over the Romanian platform up to 50 Nm from the shore, was about 553.385 t (Table 6.2.3.1.1.2 and Fig. 6.2.3.1.1.1).

Table 6.2.3.1.1.2. Assessment of turbot agglomerations in the period October 2013, demersal trawl survey, Romanian area.

Depth range (m)	0 - 30m	30 – 50m	50-70 m	Total
Investigated area (Nm^2)	625	1075	450	**2150**
Variation of the catches (t/ Nm^2)	0.00-0.305	0.00-0.604	0.00-0.436	**0.00-0.604**
Average catch (t/ Nm^2)	0.1535	0.08885	0.1235	**0.110677**
Biomass of the fishing agglomerations (t)	95.9375	95.51375	55.575	**237.956**
Biomass extrapolated the Romanian shelf (t)				**553.39**

Distribution of turbot CPUA (kg.Nm^{-2}) in Romanian waters by seasons is presented on Fig. 6.2.3.1.1.1.

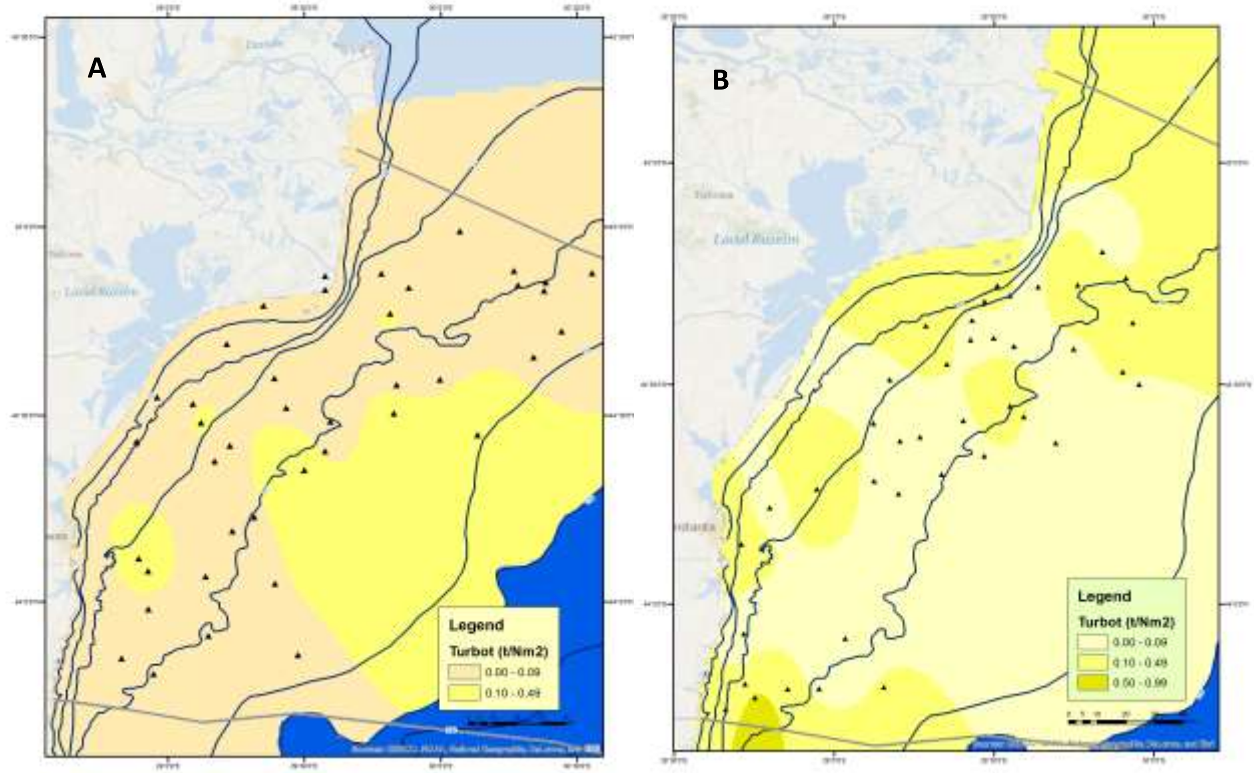


Figure 6.2.3.1.1.1. Distribution of turbot CPUA (kg.Nm^{-2}) from surveys along the Romanian Black Sea coast in spring (A) and autumn (B) seasons of 2013.

6.2.3.1.2 Trends in abundance at length or age

During the survey in May, 2013 in the Romanian Black Sea area, 24 fish were caught in total. The measured total lengths ranged between 17 and 60 cm, and the weighs - between 0.100 and 1.020 kg, respectively. From all fish, 15 individuals were juveniles (65.18 %), 3 individuals were in the range of 40-49 cm (13.05%), 3 fish were in the range of 50 - 54.9 cm (13.05%) and the remaining 2 fish (8.62 %) were in the range of 60 -70 cm.

The analysis of size and age structure of turbot catches during the spring survey highlighted the presence of mature specimens. The total lengths of individuals belong to the length classes 17.5 - 59.5 cm /0.085 – 4.350 kg. The prevailing size classes were those between 17.5 - 35.5 cm / 85 – 0.350 g (Fig. 6.2.3.1.2.1). Females fish represent 21.74 %, males - 13.08 % and the remaining 65.18 % were juvenile. The average total length during the survey was estimated at 35.36 cm and the average weight – 1.206 kg.

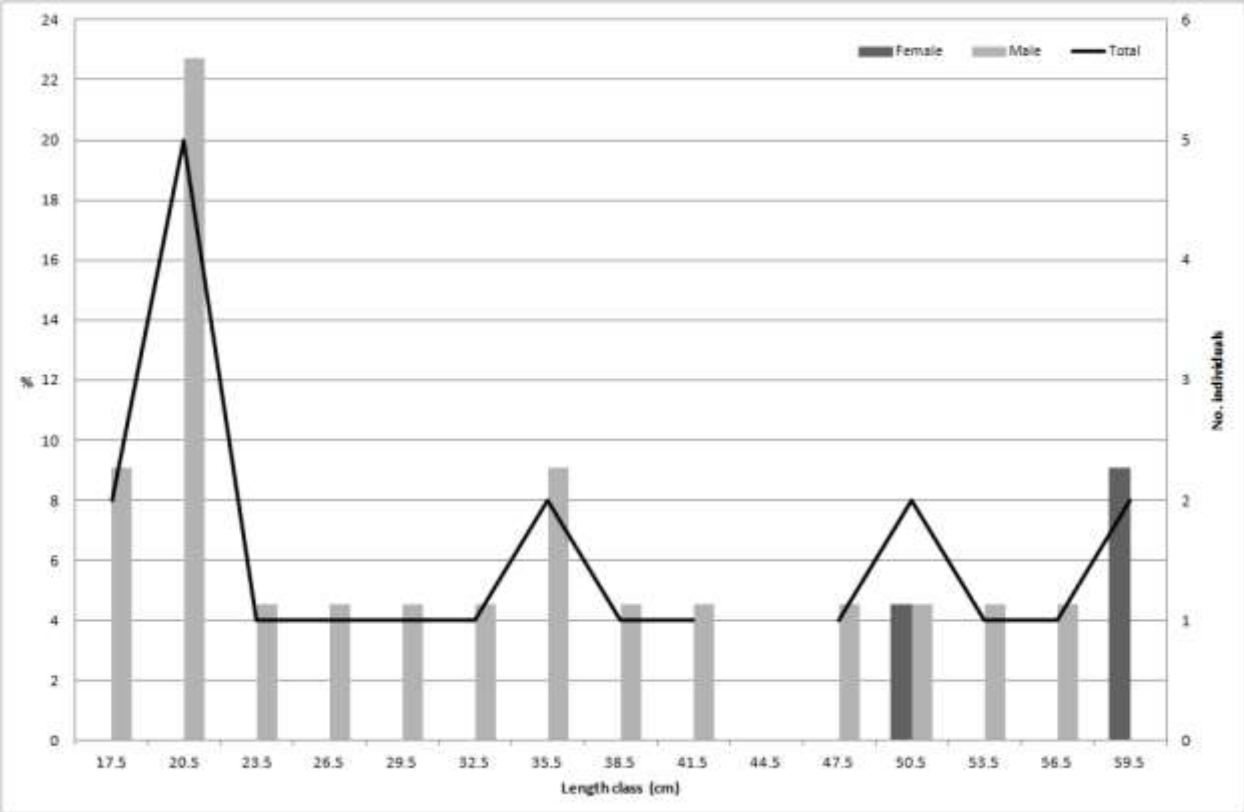


Figure 6.2.3.1.2.1. Size structure of turbot, obtained during the spring survey along the Romanian Black Sea coast in 2013.

Age composition of turbot catches includes individuals from 2 to 5 years old. Most of the fish caught were 2 years old (54.54% of all specimens analysed), 3 years (22.73%) and 4 years (18.18%), followed closely by those of 5 years (4.55%) - Fig. 6.2.3.1.2.2.

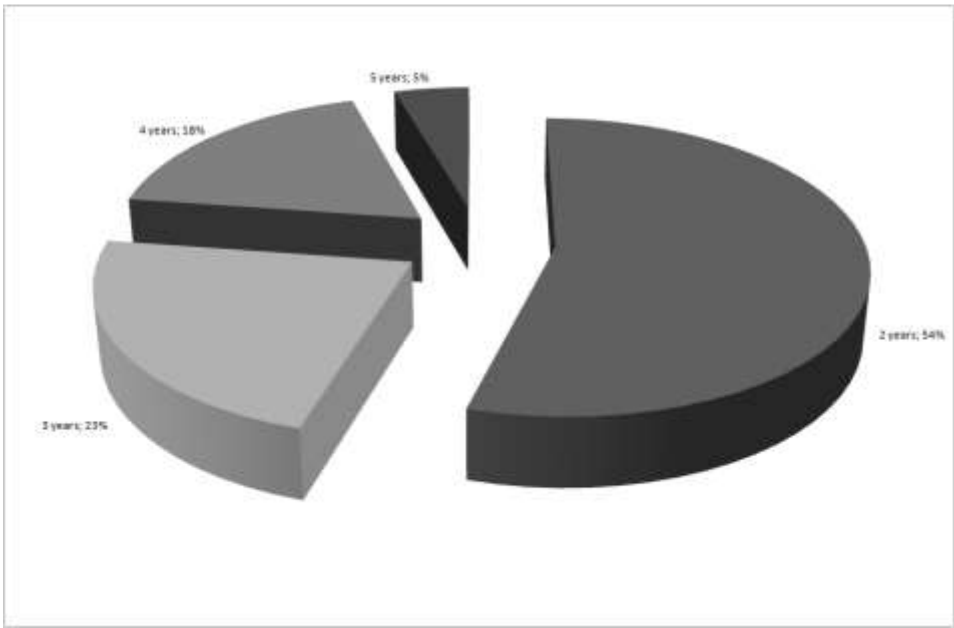


Figure 6.2.3.1.2.2. Age structure of turbot catches during the spring survey in Romanian Black Sea area in 2013.

The size structure of turbot catches during the autumn trawl survey along Romanian coast in 2013 includes individuals with total lengths varied between 14 and 71 cm and weighs between 0.050 and 5.340 kg. The total catch includes 74 individuals, from which 55 fish were juveniles (74.32 %) with the total lengths under 45 cm and the remaining 19 specimens (25.68 %) had lengths over 45 cm (sexually mature specimens). Established size structure was as follows: 13 fish belonged to size classes 46-55 cm (68 %), 3 – to the size classes 56-65 cm (16%) and 3 fish - between 66 - 71 cm (16 %). Males dominated (84.21) % / 16 specimens) in the catches compared to the females (15.79 % / 3 fish). The total catch of turbot during the survey was 77.59 kg.

The analysis of size structure of turbot during the autumn survey showed the presence of mature specimens and the high homogeneity in the structure. The length includes classes 17.5-71.5 cm / 0.827 – 5.340 kg. The dominant classes were 26.5 - 47.5 cm / 0.255 – 1.894 kg (Fig. 6.2.3.1.2.3). The sex ratio indicated a clear dominance of male fish (91.30%) compared to the females (8.70%). The average total length was estimated at 35.59 cm and the average weight – 1.087 kg.

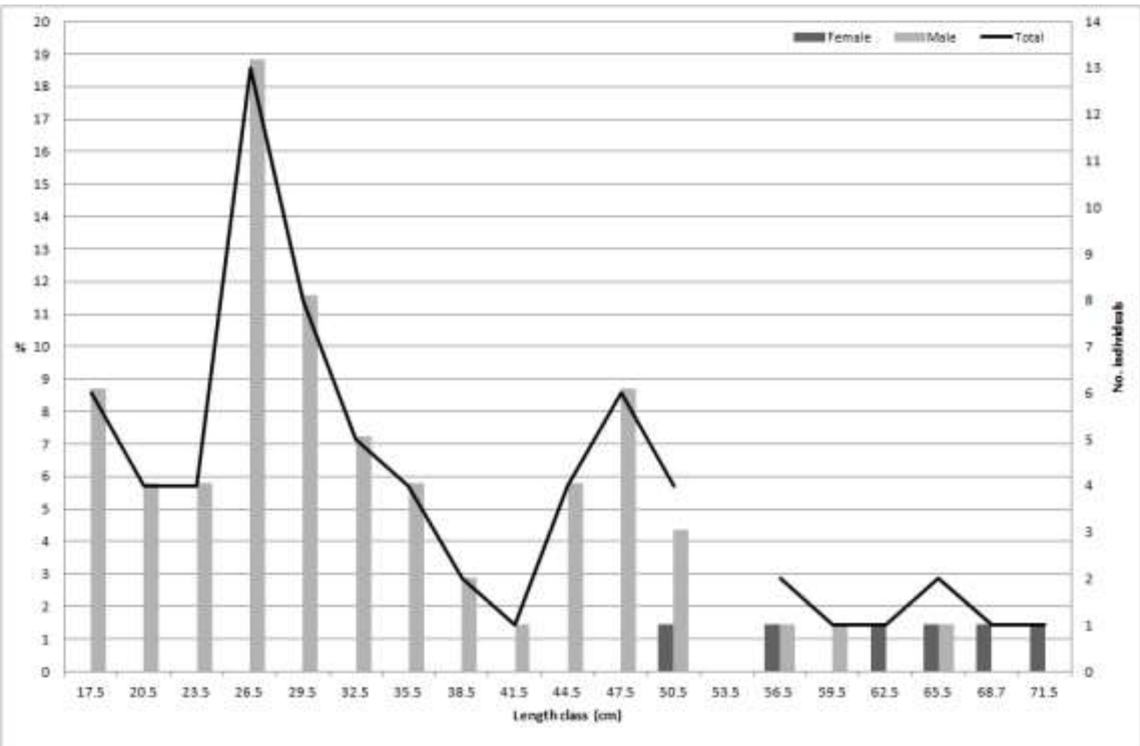


Figure 6.2.3.1.2.3. Size structure of turbot during the autumn survey along the Romanian Black Sea coast in 2013.

Age composition of turbot catches includes individuals at age between 2 and 6 years old fish. Majority of individuals were 2 years old (60.87%), followed by 3 years old fish (24.64%), 4 years old(7.25%), 5 years (2.90%) and 6 years 4.35%) (Fig. 6.2.3.1.2.4).

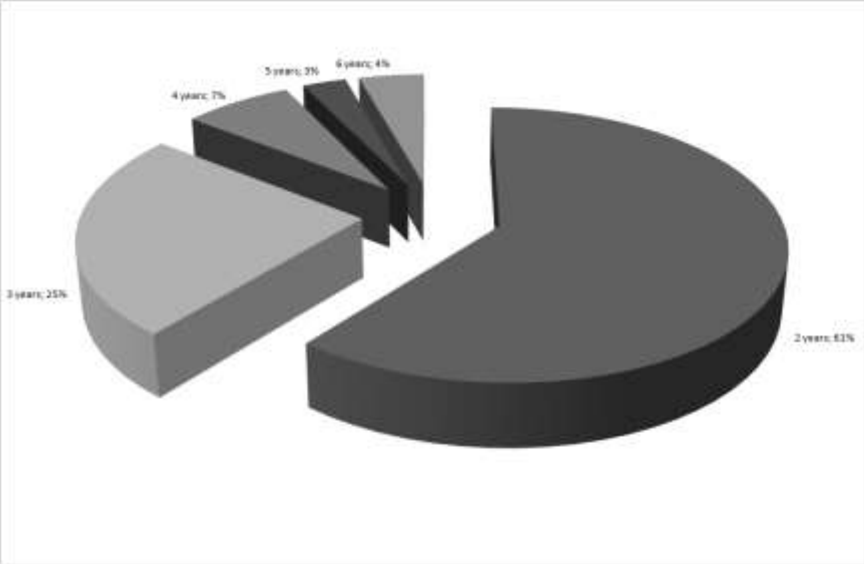


Figure 6.2.3.1.2.4. Age structure of turbot catches during the autumn survey in Romanian Black Sea area in 2013.

6.2.3.1.3 Trends in growth

The calculated values of the parameters in von Bertalanffy growth function for the Romanian area are given in Table 6.2..3.1.3.1.

Table 6.2.3.1.3.1. Values of parameters in VBGF for both genders.

Parameters	VBGF
L_∞ (cm)	76.842
k	0.39
t_0	-0.476
a	0.009218
b	0.146

6.2.3.1.4 Trends in maturity

The percentage of mature fish, estimated during the surveys along the Romanian coast is presented on Table 6.2.3.1.4.1.

Table 6.2.3.1.4.1. Turbot maturity ogive for Romanian area in 2013.

Age	%Mature
1	0
2	0
3	68
4	100
5	100
6	100
7	100

6.2.3.1.5 Abundance and biomass

The collection of fishery independent information regarding the state of the turbot stock in the EU waters was carried on in 2013 in Romanian area, but not in Bulgarian area. Fig. 6.2.3.1.5.1 shows the trends in the estimated biomass indices for Bulgaria and Romania (Maximov et al, 2006, 2008, 2009; Maximov et al, 2010a, Maximov et al, 2010b; Radu et al, 2009a; Radu et al, 2009b, Radu et al, 2010a; Radu et al, 2010b, 2011, 2012; Panayotova et.al., 2006, 2007a, 2007b, 2008a, 2008b, 2009, 2010, 2011a, 2011b, 2012, 2013). The biomass index continues to decrease in Romanian area in 2013.

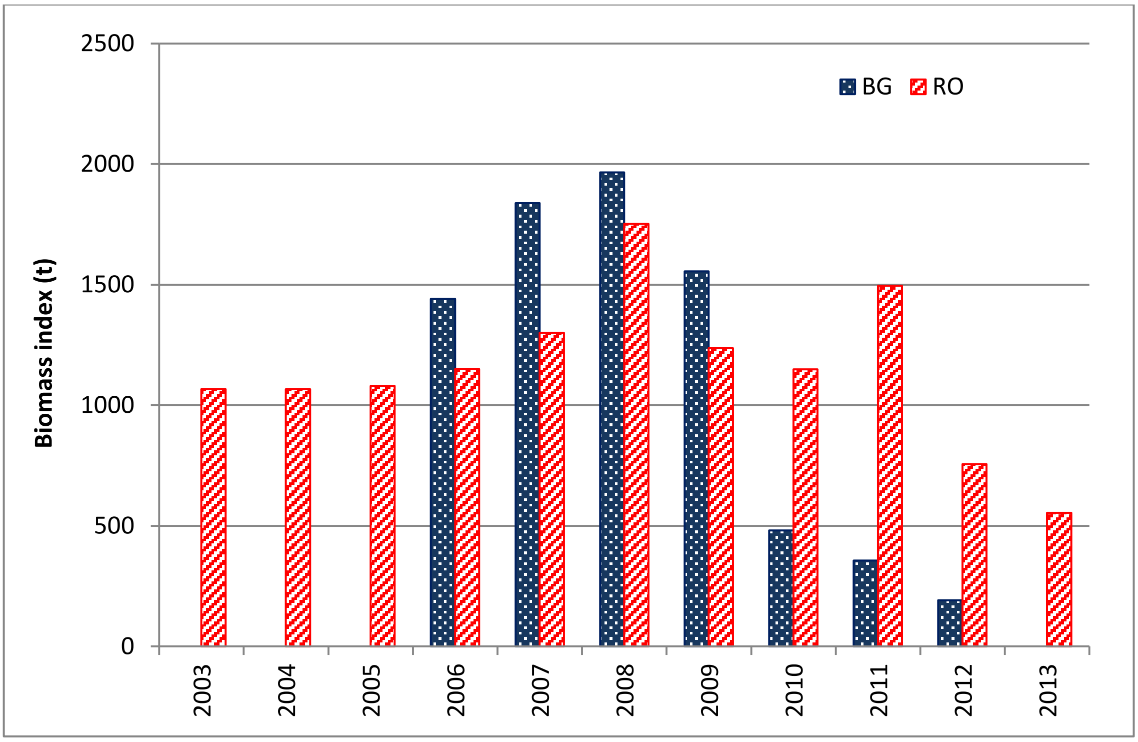


Figure 6.2.3.1.5.1. Biomass indices derived from national surveys in Bulgarian and Romanian areas during the period 2003 – 2013.

6.2.3.2 Method 2 Survey on Turkish commercial fishing vessels

Case study survey (KARTRİP: Back Sea Trawl Fisheries) involves a total number of 486 fishing vessels with overall length between 12 and 30 m, which actively operate in the Eastern (SSA) (154) and Western (332) Black Sea area.

6.2.3.2.1 Geographical distribution patterns

Estimated biomass indices of pooled data are mapped for the each part of Turkish Black Sea area (Fig. 6.2.3.2.1.1 and Fig. 6.2.3.2.1.2). The mean abundance index is estimated as 4.60 $kg.km^{-2}$ in the trawl samplings conducted between 18 m and 145 m depths along the whole Turkish Black Sea littoral zone during the fishing season (15 September – 30 December and from 1 January to 15 April in 2013).

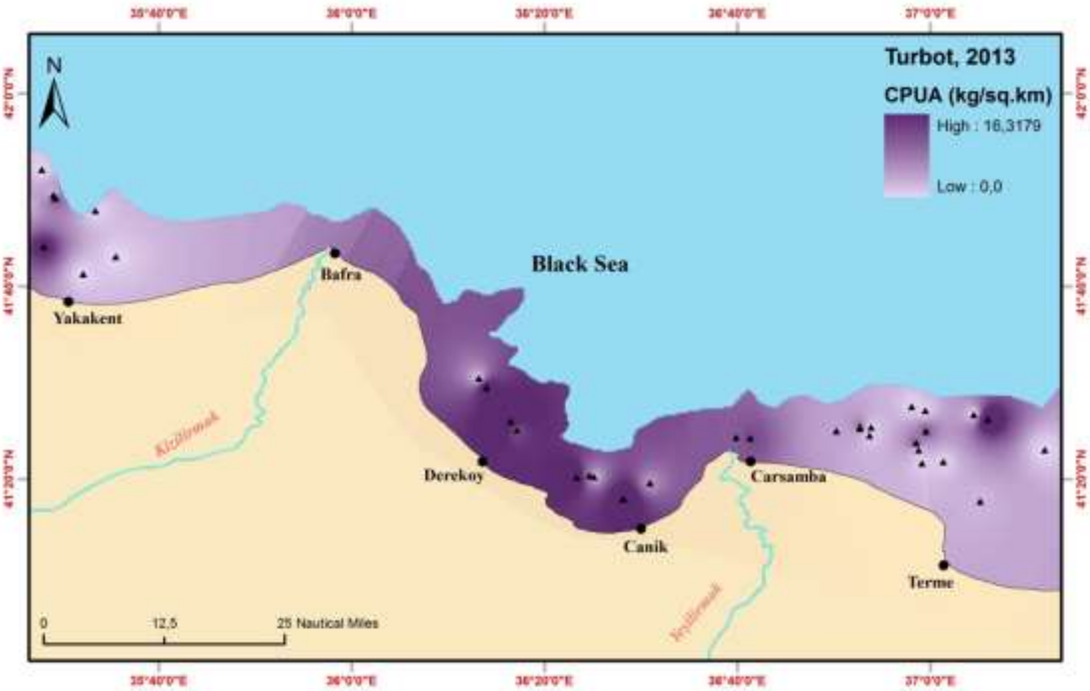


Figure 6.2.3.2.1.1. Biomass indices for turbot in the Samsun Shelf Area, 2013 (all data included).

Figure 6.2.3.2.1.2. Map of biomass indices in the Western Black Sea Turkish Region, 2013 (all data included).

6.2.3.2.2 Trends in abundance at length or age

Average length and weight frequency distributions by age groups, obtained during the survey, are presented in Tab. 6.2.3.2.2.1 and Fig. 6.2.3.2.2.1. The age ranged between 0 and 8 years. The mean length and body weight was estimated as 38.4±0.90 (11.9-81.3) cm and 1305.4±95.6 (25.2-10200) g, respectively.

Table 6.2.3.2.2.1. The age, average length and body weight distributions of turbot for Turkish Black Sea Coast in 2013.

Age group	Length (cm)	Weight (g)	N
0	15.3	77.7	3
1	22.0	192.8	23
2	33.1	453.9	52
3	38.5	1060.3	13
4	43.5	1480.7	34
5	49.5	2201.7	41
6	57.1	3162.5	4
7	59.5	3460.0	1
8	60.0	4250.0	1

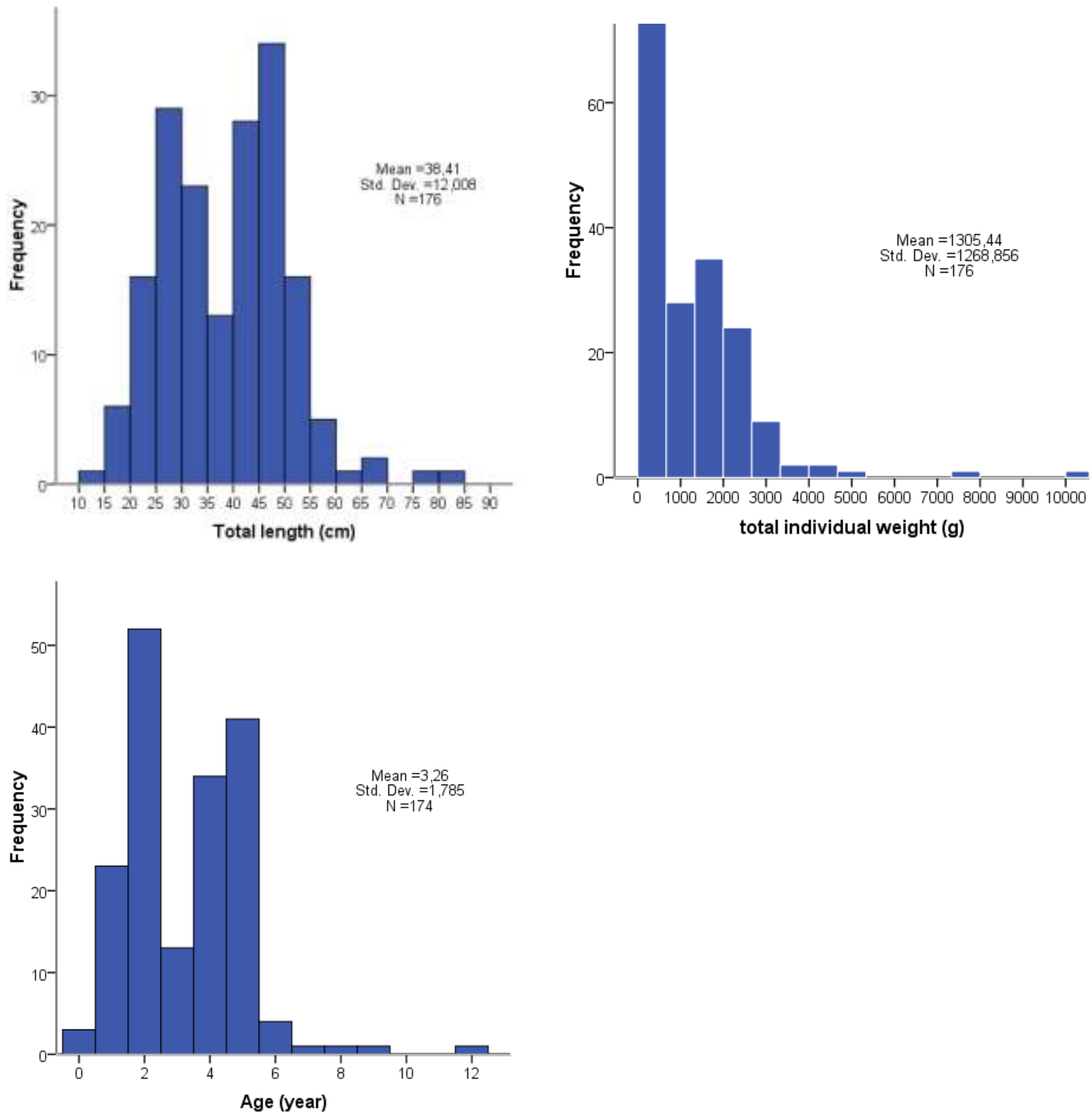


Figure 6.2.3.2.2.1. The length, weight and age frequency distribution of turbot population along Turkish Black Sea Coast in 2013.

6.2.3.2.3 Trends in growth

The von Bertalanffy growth parameters were estimated as: L_∞= 85.96 cm, K=0,342 year^{-1} and t_0=-1.153 year. The constant and the slope in the length-weight relationship was calculated as a=0.013 and b=3.068 (R^2= 0.98) (Fig. 6.2.3.2.3.1) for the whole sub-sampling (n=176) periods in 2013.

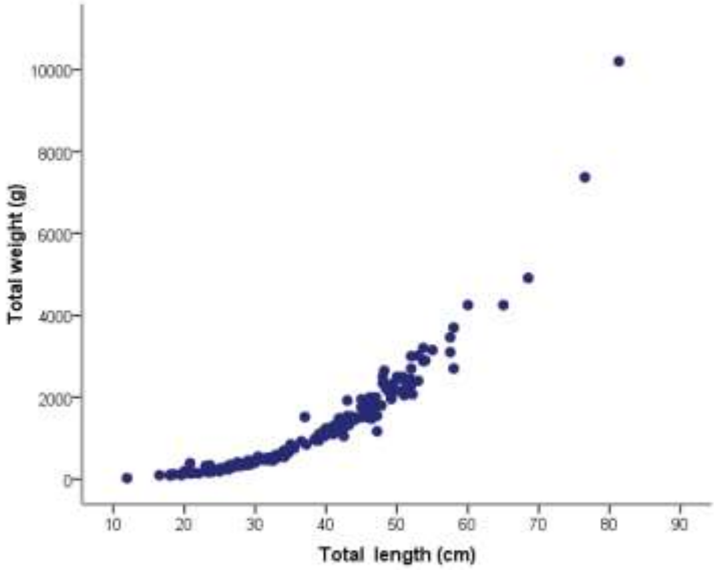


Fig. 6.2.3.2.3.1. Turbot length-weight relationship in 2013.

6.2.3.2.4 Trends in maturity

No analyses conducted

6.2.3.2.5 Abundance and biomass

The records obtained from DG of Fisheries and Aquaculture, SUBIS 2013 indicated that the turbot landing reached its maximum in September and in early fall (October and November) during the fishing period between 15 September and 15 April (Fig. 6.2.3.2.5.1). The highest CPUE values were estimated as 1.17 kg/hour/vessel in September. The CPUE value reaches its minimum in winter months (January-February) (Fig. 6.2.3.2.5.1). The average CPUE was estimated at 0.71 kg/h/vessel. Number of average operation per day was 5 (4-7) and the active average operation duration was 8.8 h.

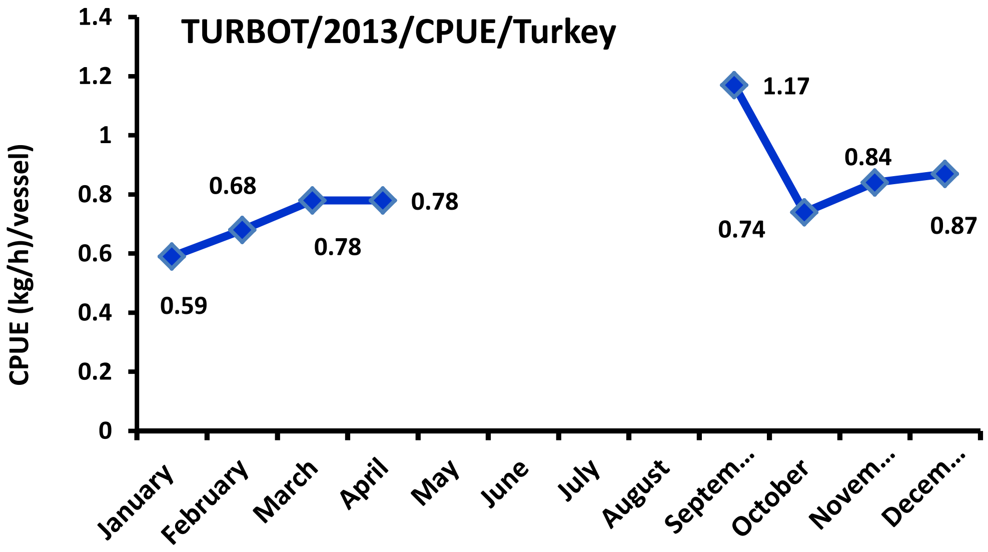


Figure 6.2.3.2.5.1. Monthly average CPUE (kg/h/vessel) of turbot for commercial trawl fisheries in the Turkish Black Sea, 2013.

The catch per unit effort (CPUE) and biomass indices (CPUA) estimated from commercial fishing vessels in 2013 are presented in Table 6.2.3.2.5.1.

Table 6.2.3.2.5.1. Turkish Black Sea turbot catch per unit effort (kg.h^{-1}) and biomass indices (kg.km^{-2}) in 2013.

Region	N	Minimum	Maximum	Mean	Std. Error	Std. Deviation
CPUE/SSA	42	0.00	3.1	**0.7**	0.16	0.94
CPUE/ WBS	65	0.00	3.5	**0.8**	0.13	1.05
CPUA/ SSA	42	0.00	19.6	**1.3**	0.83	5.41
CPUA/ WBS	65	0.00	19.3	**5.2**	0.78	6.25

6.2.4 Assessment of historical parameters

6.2.4.1 Method 1: SAM

Turbot stock in the Black Sea was assessed by state-space assessment model (SAM) (Nielsen et al., 2012) in FLR environment.

6.2.4.2 Justification

The data set for the period 1950-2013 was compiled using the historical data sources (Ivanov, Beverton, 1985; Ivanov, Karapetkova, 1979; Prodanov et. al, 1997, Daskalov et.al, 2012; Sampson et.al, 2013) and new data for 2013. Available data of total landings, catch at ages, weights and maturity at age are considered appropriate for assessingthe stock using the state-space assessment model (SAM) (Nielsen et al., 2012) in FLR environment. The SAM environment is encapsulated into the Fisheries Library in R (FLR) (Kell et al., 2007) in the form of the package “FLSAM”. The state-space assessment model (SAM) is an assessment model which is used for several assessments within ICES and it has been used for the assessment of Black Sea turbot since 2012. The model allows selectivity to evolve gradually over time. It has fewer model parameters than full parametric statistical assessment models, with quantities such as recruitment and fishing mortality modelled as random effects. All assessments are performed with version 0.99-3 of FLSAM, together with version 2.5 of the FLR library (FLCore). Five tuning series (4 surveys and 1 commercial CPUE series were compiled from previous assessments (Daskalov et al., 2012) and recent data. In 2013, only 2 surveys were updated – Romanian research surveys and Turkish CPUE survey.

6.2.4.3 Input parameters

Input data types and details are given in Tab. 6.2.4.3.1.

Table 6.2.4.3.1. Input data, used for turbot stock assessment by SAM.

Name	Type	Year range	Age range	Data modifications	Variable from year to year?
LA(1)	Catch in tonnes	1950 - 2013	2 - 10+	See note 1	Yes
CN(2)	Catch-at-age in numbers	1950 - 2013	2 - 10+	See note 2	Yes
CW(3)	Weight-at-age in the commercial catch	1950 - 2013	2 - 10+	See note 3	Yes
SW(3)	Weight-at-age of the spawning stock	1950 - 2013	2 - 10+	See note 3	Yes
NM(4)	Natural mortality	1950 - 2013	2 - 10+	See note 4	No
PF	Proportion of fishing mortality before spawning	1950 - 2013	2 - 10+	No	No
MO(5)	Proportion mature-at-age	1950 - 2013	2 - 10+	See note 5	No
PM	Proportion of natural mortality before spawning	1950 - 2013	2 - 10+	No	No
TUN	West Ukrainian survey	1989 - 2007	4 – 10+	No	No
	East Ukrainian survey	1989 - 2006	2 – 10+	No	No
	Romanian survey	2003 - 2013	4 - 9	Yes	Yes
	Bulgarian survey	2006 - 2012	2 - 7	Yes	No
	Turkish commercial CPUE	1987 - 2013	2 - 10+	Yes	Yes

(1) Assessment and qualitative assumptions about the IUU (Illegal, Unregulated and Unreported) fishing of turbot were made.
(2) Catch-at-age data for 2013 is derived from the raised national landings statistics by countries (Georgia is not included) and added to the historic catch at age data set compiled during the previous assessments. The catch-at-age data was corrected to the official landings (SOP corrections). They do represent officially reported landings and do not include any discards but they do take into account the IUU catches during the period 2002 - 2013.
(3) The mean weights at ages in the stock for the period 1989-2013 were assumed equal to the catch weights at age in the landings due to lack of data. The averaged weights-at-age during the period 1989 – 1993 were used to estimate weight at age in 1950 – 1988.
(4) A vector of natural mortality (M) by age groups was estimated by ProdBIOM ver.2009 (Abella et.al, 1997, 1998) using different sets of parameters in VBGF (Tab. 6.2.1.2.1.) estimated for the historical and the modern part of the time series.

(5) Maturity ogive was calculated as the average for the period 2007 – 2009 due to good consistency for these years and applied over the whole period.

Estimates of IUU catches (2002-2013) are based on some specific knowledge of illegal fishing along the north-west and west shelf areas (waters of Ukraine, Romania and Bulgaria). Prior to 2002, Turkish vessels have been known to fish illegally inside the territorial waters of Ukraine, Romania and Bulgaria. Their catch has been landed in Turkey and respectively reported by the Turkish landing statistics. By 2001, authorities in Ukraine, Romania and Bulgaria have severed the control against illegal Turkish fishers. These actions are reflected by a sudden drop in Turkish landings in 2002. Since 2002, most of the illegal fishing in Ukrainian, Romanian and Bulgarian waters is carried out by local fisheries. Some of them are known to disembark their catch into Turkish vessels outside of the territorial waters. These illegal catches by Ukrainian, Romanian and Bulgarian fishers are not included in respective national catch statistics. We have assumed that IUU catches in Ukrainian, Romanian and Bulgarian waters after 2001 are of the same approximate size as they have been prior to 2002 (when taken by Turkish fishers). The IUU catches in 2002-2013, were estimated by rising the cumulative landings of Ukraine, Romania and Bulgaria by a proportion given by the following expression: (mean Turkish landing in 1993-2001 - mean Turkish landing in 2002-2010) divided by the mean cumulative landings by Ukraine, Romania and Bulgaria in 2002-2010. The estimated proportion equals 4.7, that mean that IUU catches in Ukrainian, Romanian and Bulgarian waters are about 5 times larger than the reported landings, which represent a conservative estimate that is confirmed by anecdotal information about illegal fishing of turbot (Table 6.2.2.3.1.1, Fig. 6.2.4.3.1).

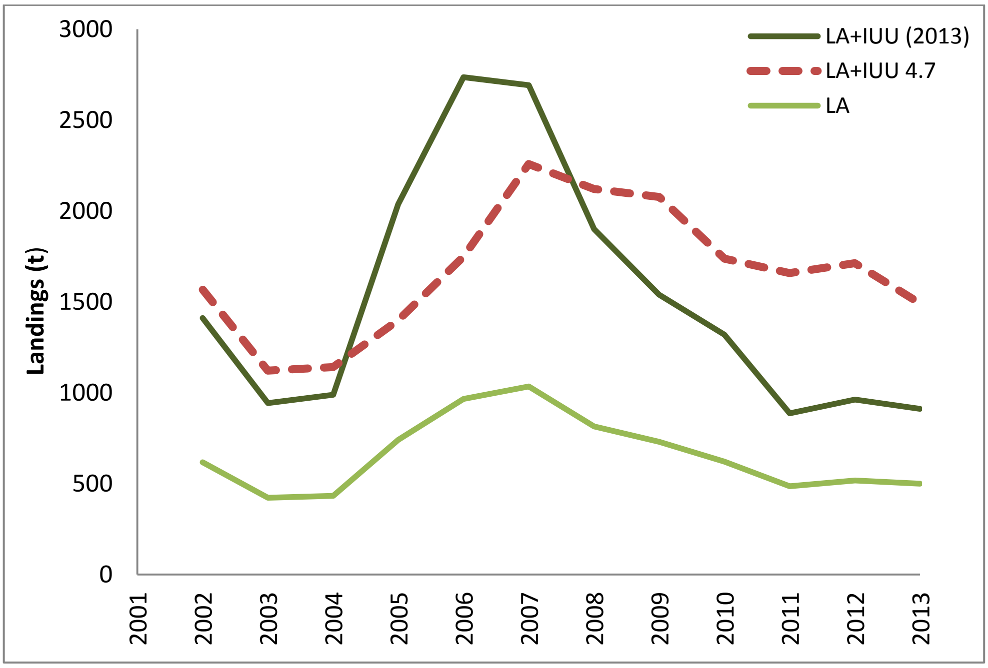


Figure 6.2.4.3.1. Total turbot landings in Black Sea during 2002 - 2013. Officially reported landings (LA, green line) are compared to the total catch in Black Sea, including conservative estimates of IUU catch (red line), where the Bulgarian, Romanian and Ukrainian landings are multiplied by 4.7. Dark green line present the estimates of total catch including IUU, following STECF (2013).

Prior to the assessment run, the exploration analysis of the data was performed and data was assessed as appropriate for stock assessment purposes. The analyses of tuning series are shown on Fig. 6.2.4.3.2.

STECF EWG 14 14 used all of the 5 series for tuning the SAM model, obtained from Bulgarian, Romanian and Ukrainian fishery-independent surveys and CPUE of the Turkish fleet, for ages, selected from the data exploration analysis covering the period 1987-2013. Internal consistency plots were used to select the age classes within the updated Romanian and Turkish CPUE surveys to be used in the SAM model. The ages selected for each of the surveys are the same as the assessment in 2013 (Sampson et.al, 2013) and are reported in Tab. 6.2.4.3.1. The exploration analysis selected the ages 4 – 9 from Romanian survey and ages 2 – 10 from Turkish commercial CPUE (Fig. 6.2.4.3.2, Table 6.2.4.3.1).

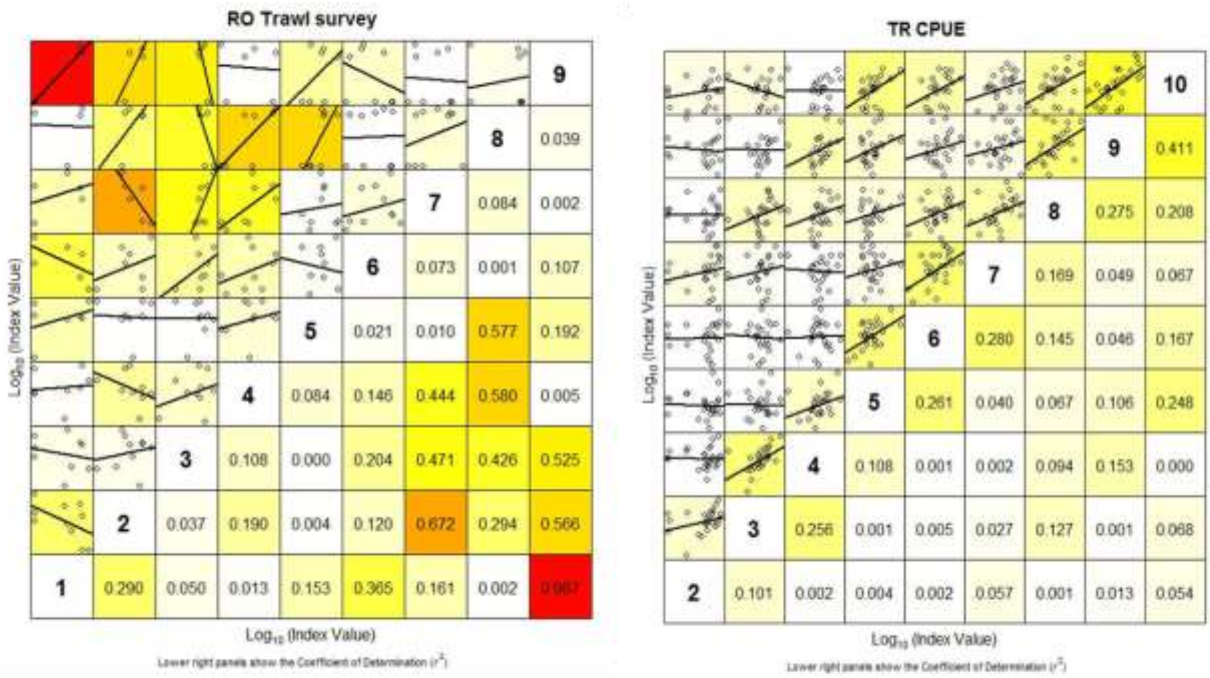


Figure 6.2.4.3.2. Fitted linear relationships of cohort trends (i.e. internal consistency) within the two updated tuning series used in the analysis.

SAM input data (Table. 6.2.4.3.2- Table. 6.2.4.3.8)

Table 6.2.4.3.2 Turbot in the Black Sea 1950-2013. Total catches including estimated IUU catches.

Year	Catch	Year	Catch	Year	Catch
1950	3932	**1972**	3049	**1994**	2144
1951	4741	**1973**	3705	**1995**	2943
1952	5217	**1974**	1696	**1996**	2048
1953	4985	**1975**	1273	**1997**	1025
1954	4505	**1976**	1584	**1998**	1588
1955	3678	**1977**	2012	**1999**	1953
1956	3623	**1978**	2160	**2000**	2789
1957	3017	**1979**	5447	**2001**	2557
1958	4289	**1980**	2843	**2002**	1567
1959	4653	**1981**	3276	**2003**	1122
1960	2680	**1982**	4662	**2004**	1142
1961	3058	**1983**	5307	**2005**	1400
1962	2904	**1984**	2852	**2006**	1751

1963	3812	**1985**	527	**2007**	2259
1964	3666	**1986**	428	**2008**	2122
1965	3063	**1987**	849	**2009**	2078
1966	3093	**1988**	1116	**2010**	1738
1967	2709	**1989**	1460	**2011**	1659
1968	2931	**1990**	1393	**2012**	1714
1969	3076	**1991**	935	**2013**	1522
1970	5273	**1992**	439		
1971	3052	**1993**	1603		

Table 6.2.4.3.3. Catch-at-age data (10^3 individuals) including estimated IUU catches.

age/year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
2	16.397	19.748	23.692	25.119	21.002	18.31	18.04	14.862	21.169	33.373
3	112.918	135.972	164.901	176.873	146.621	128.763	126.874	130.048	259.27	355.666
4	216.681	260.864	321.152	349.953	286.75	254.327	250.607	293.781	383.447	567.8
5	280.36	337.472	420.244	463.324	376.404	336.296	331.387	387.218	486.748	402.023
6	226.152	272.659	302.097	291.305	261.462	214.675	211.467	220.132	309.756	293.197
7	180.133	217.37	224.295	195.543	189.597	145.942	143.719	77.563	138.655	157.728
8	115.062	138.899	138.981	115.318	116.204	86.64	85.307	41.332	57.23	64.621
9	41.986	50.659	52.827	46.801	44.818	34.857	34.327	12.084	18.122	17.733
10	25.562	30.857	30.872	25.611	25.811	19.242	18.946	6.269	8.541	11.175
age/year	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**
2	27.762	8.915	14.186	43.495	25.964	11.486	21.708	61.68	35.427	30.656
3	138.435	131.955	135.825	235.771	372.001	169.355	132.49	251.327	306.856	334.071
4	231.44	278.865	281.284	235.009	312.064	320.28	206.362	235.719	319.099	362.644
5	205.908	229.911	172.624	262.933	271.244	265.077	267.176	175.771	204.389	262.83
6	182.972	209.673	216.155	290.267	227.835	172.629	236.643	192.666	178.719	186.969
7	109.8	112.386	121.817	181.621	136.976	112.799	131.96	93.375	113.986	98.328
8	58.186	75.748	72.532	94.435	82.583	69.137	70.776	54.007	49.266	40.67
9	13.454	20.071	17.249	15.62	18.076	17.422	13.6	13.28	9.798	8.641
10	9.369	11.085	5.081	6.805	6.018	9.17	8.142	7.644	4.943	5.437
age/year	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**
2	72.647	1.814	1.875	3.4	2.089	0.211	27.663	20.331	22.42	3.575
3	353.927	47.933	72.838	47.204	5.576	11.202	86.728	47.836	64.459	148.2
4	171.982	434.073	49.816	62.156	8.826	30.674	35.072	22.505	50.179	106.001
5	540.574	200.784	202.466	276.994	44.395	145.872	103.805	73.658	195.913	406.363
6	310.77	188.526	209.334	237.515	102.688	99.776	93.079	93.499	134.19	331.837
7	234.828	142.951	175.418	208.852	101.49	63.921	64.781	89.041	99.558	252.491
8	83.85	42.138	72.451	77.682	36.091	19.512	19.124	29.572	30.561	77.947
9	38.218	16.895	28.245	34.258	22.168	7.251	12.702	24.734	19.218	51.679
10	41.594	15.546	32.019	49.547	39.956	9.98	34.436	64.526	32.096	107.789

age/year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	12.814	18.143	0.064	0.067	0.061	0.055	0.056	0.059	0.057	11.804
3	75.89	75.342	115.985	158.094	53.836	0.776	0.056	1.185	0.057	33.052
4	41.273	24.159	69.497	98.656	49.529	2.251	0.224	8.296	0.226	41.147
5	162.346	75.826	201.974	375.707	45.761	4.347	4.938	12.593	19.53	59.359
6	193.383	136.36	171.426	212.477	75.37	8.461	5.78	47.704	29.559	68.128
7	147.618	166.726	172.368	192.419	80.754	15.215	11.783	13.926	24.457	34.739
8	49.345	91.002	76.879	77.62	66.218	7.22	0.225	13.63	38.181	16.863
9	25.463	51.087	70.832	70.771	45.761	12.188	2.581	8.593	8.622	15.852
10	52.008	83.458	157.448	150.266	121.131	27.169	30.806	42.222	55.599	52.614
age/year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
2	55.811	70.661	42.675	436.461	122.823	67.184	38.396	0.01	0.01	0.01
3	68.144	120.758	29.139	366.249	283.93	47.037	40.687	62.311	8.951	69.841
4	104.67	87.588	29.625	150.765	224.63	311.408	130.189	48.751	25.789	114.285
5	94.524	60.376	17.215	63.55	204.966	486.222	168.863	43.585	73.551	76.19
6	37.011	47.027	13.473	25.902	62.968	246.691	210.143	50.365	176.184	184.125
7	29.226	36.382	15.199	14.71	44.668	87.013	97.104	68.768	97.091	146.031
8	20.721	8.41	9.901	14.699	39.514	18.741	42.477	32.285	54.775	25.397
9	12.93	6.112	2.271	11.461	33.673	2.444	9.999	13.56	11.2	12.698
10	35.602	6.112	2.453	3.249	10.323	2.444	0.011	3.229	0.01	6.349
age/year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
2	110.151	28.426	84.166	24.442	20.082	51.322	94.06	117.382	128.957	83.862
3	98.406	42.512	163.214	42.607	51.124	153.999	125.794	220.447	139.244	224.049
4	132.503	133.008	123.606	39.716	62.95	157.707	170.44	418.457	312.066	251.296
5	107.75	247.27	145.575	66.472	77.473	109.903	125.757	201.385	197.272	162.742
6	78.666	322.937	101.483	94.014	85.809	52.807	76.834	103.231	132.293	93.987
7	197.593	103.839	72.104	100.788	58.606	43.57	65.849	37.013	69.431	117.221
8	110.854	22.142	5.964	16.856	31.719	28.872	12.568	4.862	24.002	19.222
9	56.976	2.584	1.296	0.947	3.56	2.512	16.305	4.737	3.987	2.761
10	17.343	7.753	1.556	0.568	0.028	0.809	0.018	0.508	1.524	0.029
age/year	**2010**	**2011**	**2012**	**2013**						
2	9.311	294.674	58.215	135.845						
3	29.855	92.415	94.85	57.522						
4	103.768	83.081	156.768	207.847						
5	183.663	107.532	131.293	212.49						
6	153.727	46.091	46.144	85.401						
7	86.314	56.057	71.553	37.768						
8	40.255	63.96	43.978	18.225						
9	13.489	28.782	21.683	10.578						
10	3.321	8.611	5.676	1.111						

Table 6.2.4.3.4. Weight-at-age in catch (kg).

age/year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568
year											

age/year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	0.869	0.869	0.869	0.869	0.869	0.869	1	0.73	0.777	0.947	0.893
3	1.265	1.265	1.265	1.265	1.265	1.265	1.4	1.247	1.153	1.427	1.1
4	1.765	1.765	1.765	1.765	1.765	1.765	1.8	1.777	1.71	1.997	1.543
5	2.243	2.243	2.243	2.243	2.243	2.243	2.2	2.16	2.12	2.647	2.087
6	3.289	3.289	3.289	3.289	3.289	3.289	3.3	3.243	3.03	3.907	2.963
7	4.377	4.377	4.377	4.377	4.377	4.377	4	3.9	4.257	5.283	4.443
8	5.667	5.667	5.667	5.667	5.667	5.667	5.3	5.447	5.467	6.3	5.82
9	7.368	7.368	7.368	7.368	7.368	7.368	6.6	6.5	6.6	8.8	8.34
10	10.568	10.568	10.568	10.568	10.568	10.568	12.117	12.278	9.537	9.537	9.369

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0.76	0.72	1.083	1.083	1.083	1.083	1.083	1.083	0.852	0.793	0.973

3	1.07	0.953	1	1	1.3	1.3	1.227	1.3	1.283	1.292	1.429
4	1.593	1.57	1.6	1.6	1.7	1.7	1.567	1.7	1.938	1.975	1.953
5	2.083	2.22	2.1	2.1	2.2	2.2	2.223	2.3	2.532	2.4	2.517
6	2.597	2.993	2.8	2.8	3.1	3.1	2.87	3.1	3.197	3.116	3.183
7	4.2	4.423	4.3	4.3	4.3	4.3	3.913	4.1	4.117	4.078	4.238
8	5.9	6	6	6	6	6	5.233	5.7	5.4	5.4	5.796
9	8.3	8.5	9.5	9.5	7	7	6.62	9.5	6.6	6.6	6.8
10	9.473	9.5	10	10.5	10.314	9.5	8.321	12.667	10.25	10	9.921

age/year	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	0.843	0.999	0.794	0.571	0.66	0.683	0.604	0.594	0.454
3	1.321	1.507	1.4	1.356	1.155	1.188	1.129	1.39	1.227
4	1.938	2.114	1.891	1.791	1.749	1.726	1.658	1.956	1.592
5	2.545	2.68	2.441	2.42	2.423	2.511	2.363	2.64	2.257
6	3.436	3.501	3.119	3.001	3.415	2.622	3.192	3.364	3.087
7	4.388	4.467	4.706	4.015	4.197	3.846	3.708	4.272	3.93
8	5.78	5.828	6.06	4.694	5.192	5.177	4.962	5.645	4.662
9	7.5	7.4	7.5	5.697	6.323	5.999	5.627	6.552	5.946
10	9.842	9.421	9	6.643	7.109	7.575	7	6.894	7

Table 6.2.4.3.5. Weight-at-age in the stock (kg).

age/year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869

3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	0.869	0.869	0.869	0.869	0.869	0.869	1	0.73	0.777	0.947	0.893
3	1.265	1.265	1.265	1.265	1.265	1.265	1.4	1.247	1.153	1.427	1.1
4	1.765	1.765	1.765	1.765	1.765	1.765	1.8	1.777	1.71	1.997	1.543
5	2.243	2.243	2.243	2.243	2.243	2.243	2.2	2.16	2.12	2.647	2.087
6	3.289	3.289	3.289	3.289	3.289	3.289	3.3	3.243	3.03	3.907	2.963
7	4.377	4.377	4.377	4.377	4.377	4.377	4	3.9	4.257	5.283	4.443
8	5.667	5.667	5.667	5.667	5.667	5.667	5.3	5.447	5.467	6.3	5.82
9	7.368	7.368	7.368	7.368	7.368	7.368	6.6	6.5	6.6	8.8	8.34
10	10.568	10.568	10.568	10.568	10.568	10.568	12.117	12.278	9.537	9.537	9.369

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0.76	0.72	1.083	1.083	1.083	1.083	1.083	1.083	0.852	0.793	0.973
3	1.07	0.953	1	1	1.3	1.3	1.227	1.3	1.283	1.292	1.429
4	1.593	1.57	1.6	1.6	1.7	1.7	1.567	1.7	1.938	1.975	1.953
5	2.083	2.22	2.1	2.1	2.2	2.2	2.223	2.3	2.532	2.4	2.517
6	2.597	2.993	2.8	2.8	3.1	3.1	2.87	3.1	3.197	3.116	3.183
7	4.2	4.423	4.3	4.3	4.3	4.3	3.913	4.1	4.117	4.078	4.238
8	5.9	6	6	6	6	6	5.233	5.7	5.4	5.4	5.796
9	8.3	8.5	9.5	9.5	7	7	6.62	9.5	6.6	6.6	6.8
10	9.473	9.5	10	10.5	10.314	9.5	8.321	12.667	10.25	10	9.921

age/year	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	0.843	0.999	0.794	0.571	0.66	0.683	0.604	0.594	0.454
3	1.321	1.507	1.4	1.356	1.155	1.188	1.129	1.39	1.227
4	1.938	2.114	1.891	1.791	1.749	1.726	1.658	1.956	1.592
5	2.545	2.68	2.441	2.42	2.423	2.511	2.363	2.64	2.257
6	3.436	3.501	3.119	3.001	3.415	2.622	3.192	3.364	3.087
7	4.388	4.467	4.706	4.015	4.197	3.846	3.708	4.272	3.93
8	5.78	5.828	6.06	4.694	5.192	5.177	4.962	5.645	4.662
9	7.5	7.4	7.5	5.697	6.323	5.999	5.627	6.552	5.946
10	9.842	9.421	9	6.643	7.109	7.575	7	6.093	7

Table 6.2.4.3.6. Natural mortality.

age/year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114

3	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105

age/year	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105

age/year	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105

age/year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0.114	0.114	0.114	0.114	0.114	0.114	0.146	0.146	0.146	0.146	0.146
3	0.11	0.11	0.11	0.11	0.11	0.11	0.139	0.139	0.139	0.139	0.139
4	0.108	0.108	0.108	0.108	0.108	0.108	0.136	0.136	0.136	0.136	0.136

5	0.107	0.107	0.107	0.107	0.107	0.107	0.134	0.134	0.134	0.134	0.134
6	0.106	0.106	0.106	0.106	0.106	0.106	0.133	0.133	0.133	0.133	0.133
7	0.106	0.106	0.106	0.106	0.106	0.106	0.132	0.132	0.132	0.132	0.132
8	0.105	0.105	0.105	0.105	0.105	0.105	0.131	0.131	0.131	0.131	0.131
9	0.105	0.105	0.105	0.105	0.105	0.105	0.13	0.13	0.13	0.13	0.13
10	0.105	0.105	0.105	0.105	0.105	0.105	0.13	0.13	0.13	0.13	0.13

age/year	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146
3	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139
4	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136
5	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
6	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133
7	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132
8	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131
9	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
10	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
10	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13

Table 6.2.4.3.7. Proportion of mature fish.

age/year	1950	1951	1952	1953	1954	1955	1956	1957
2	0	0	0	0	0	0	0	0
3	0.4316667	0.4316667	0.4316667	0.4316667	0.431667	0.4316667	0.4316667	0.431667
4	0.6783333	0.6783333	0.6783333	0.6783333	0.678333	0.6783333	0.6783333	0.678333
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1

age/year	1958	1959	1960	1961	1962	1963	1964	1965
2	0	0	0	0	0	0	0	0
3	0.4316667	0.4316667	0.4316667	0.4316667	0.431667	0.4316667	0.4316667	0.431667
4	0.6783333	0.6783333	0.6783333	0.6783333	0.678333	0.6783333	0.6783333	0.678333
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1

age/year	1966	1967	1968	1969	1970	1971	1972	1973
2	0	0	0	0	0	0	0	0
3	0.4316667	0.4316667	0.4316667	0.4316667	0.431667	0.4316667	0.4316667	0.431667

4	0.6783333	0.6783333	0.6783333	0.6783333	0.678333	0.6783333	0.6783333	0.678333
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1

age/year	1974	1975	1976	1977	1978	1979	1980	1981
2	0	0	0	0	0	0	0	0
3	0.4316667	0.4316667	0.4316667	0.4316667	0.431667	0.4316667	0.4316667	0.431667
4	0.6783333	0.6783333	0.6783333	0.6783333	0.678333	0.6783333	0.6783333	0.678333
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1

age/year	1982	1983	1984	1985	1986	1987	1988	1989
2	0	0	0	0	0	0	0	0
3	0.4316667	0.4316667	0.4316667	0.4316667	0.431667	0.4316667	0.4316667	0.431667
4	0.6783333	0.6783333	0.6783333	0.6783333	0.678333	0.6783333	0.6783333	0.678333
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1

age/year	1990	1991	1992	1993	1994	1995	1996	1997
2	0	0	0	0	0	0	0	0
3	0.4316667	0.4316667	0.4316667	0.4316667	0.431667	0.4316667	0.4316667	0.431667
4	0.6783333	0.6783333	0.6783333	0.6783333	0.678333	0.6783333	0.6783333	0.678333
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1

age/year	1998	1999	2000	2001	2002	2003	2004	2005
2	0	0	0	0	0	0	0	0
3	0.4316667	0.4316667	0.4316667	0.4316667	0.431667	0.4316667	0.4316667	0.431667
4	0.6783333	0.6783333	0.6783333	0.6783333	0.678333	0.6783333	0.6783333	0.678333
5	1	1	1	1	1	1	1	1

6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1
age/year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2	0	0	0	0	0	0	0	0
3	0.4316667	0.4316667	0.4316667	0.4316667	0.431667	0.4316667	0.4316667	0.431667
4	0.6783333	0.6783333	0.6783333	0.6783333	0.678333	0.6783333	0.6783333	0.678333
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1

Table 6.2.4.3.8. Tuning series.

RO Trawl	**survey**	**-**	**Configuration**								
BLACK	SEA	TURBOT	Total	2013	COMBSEX	TUNING	DATA(effort	nos at age.	Imported	from	VPA file.
min	max	plusgroup	minyear	maxyear	startf	endf					
4	9	9	2003	2013	0.45	0.55					
Index	type	:	number								
RO	Trawl	survey	-	Index	Values						
Units	:	NA									
age/year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
4	71.57	63.16	113.18	145.08	244.96	228.11	136.44	126.53	173.48	129.46	68.302
5	64.24	77.36	79.23	145.09	105.58	101.16	107.2	98.98	138.42	145.06	42.032
6	70.08	68.31	24.52	36.69	26.94	35.23	58.24	47.97	68.15	83.71	27.146
7	39.42	16.75	16.98	11.02	13.48	14.03	35.74	26.23	37.8	53.55	13.135
8	0.01	16.43	21.28	0.01	0.01	0.01	15.23	12.28	32.75	20.07	0.01
9	0.01	0.01	0.01	0.01	0.01	0.01	10.12	2.53	6.76	3.77	0.01
UKR	Trawl	survey	West	-	Configuration						
BLACK SEA	TURBOT	Total	2013	COMBSEX	TUNING	DATA(effort	nos at age).	Imported	from	VPA	file.
min	max	plusgroup	minyear	maxyear	startf	endf					
4	10	10	1989	2007	0.75	0.83					
Index	type	:	number								
UKR	Trawl	survey	West	-	Index	Values					
Units	:	NA									

age/year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
4	24.77	13.12	41.04	37.77	29.37	28.2	NA	NA	NA	19.36
5	35.74	13.83	29.7	33.15	53.37	51.25	NA	NA	NA	55.5
6	41.02	18.13	28.8	38.03	34.73	33.35	NA	NA	NA	122.93
7	20.92	19.68	21.6	28.01	33.2	31.88	NA	NA	NA	70.34
8	10.15	11.69	4.68	6.42	29.37	28.2	NA	NA	NA	37.11
9	9.54	8.71	4.14	5.4	25.03	24.03	NA	NA	NA	10.97
10	8.94	5.84	0.9	1.03	5.62	5.4	NA	NA	NA	0.01
age/year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	
4	NA	NA	60.94	50.2	23.53	45.97	20.99	176.46	153.74	
5	NA	NA	77.7	89.77	60.51	60.23	45.17	114.86	121.44	
6	NA	NA	22.85	64.96	95.99	89.02	49.18	71.32	56.85	
7	NA	NA	4.57	53.15	139.68	104.56	95.17	50.48	39.62	
8	NA	NA	0.65	6.79	33.24	40.84	70.17	7.87	9.04	
9	NA	NA	0.65	1.48	1.87	12.85	13.61	10.19	12.06	
10	NA	NA	0.65	0.89	1.12	0.01	3.23	0.01	1.29	
BG	**Trawl**	**survey**	**-**		**Configuration**					
BLACK SEA	TURBOT	Total 2013	COMBSEX	TUNING	DATA (effort	nos at age).	Imported	from VPA	file.	
min	max	plusgroup	minyear	maxyear	startf	endf				
2	7	NA	2006	2012	0.5	0.5				
Index	type	:	number							
BG	Trawl	survey	-	Index	Values					
Units	:	NA								
age/year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**			
2	222.36	124.13	171.01	19.95	5.1	38.33	9.85			
3	259.03	233.08	118.97	139.66	7.66	38.33	19.71			
4	108.8	328.24	215.63	136.59	24.24	26.35	26.28			
5	41.4	204.12	270.15	155.01	57.42	16.77	13.14			
6	24.84	86.89	161.1	102.83	37	26.35	9.85			
7	10.65	13.79	19.83	30.7	17.86	21.56	6.57			
TR CPUE	**-**		**Configuration**							
BLACK SEA	TURBOT	Total 2013	COMBSEX	TUNING	DATA(effort	nos at age).	Imported	from VPA	file.	
min	max	plusgroup	minyear	maxyear	startf	endf				
2	10	10	1987	2013	0.45	0.55				
Index	type	:	number							

TR	CPUE	-	Index	Values							
Units	:	NA									
age/ year	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**		
2	0.92	1.13	138.23	342.49	649.47	223.13	648.31	922.43	516.78		
3	18.53	1.13	387.05	418.17	1109.94	152.35	544.02	2132.38	361.81		
4	129.7	4.54	481.83	642.33	805.06	154.9	223.94	1687.02	2395.4		
5	196.9	391.07	695.1	580.06	554.94	90.01	94.4	1539.34	3740.0		
6	745.8	591.9	797.79	227.12	432.24	70.45	38.47	472.9	1897.6		
7	217.7	489.73	406.79	179.35	334.4	79.47	21.85	335.47	669.31		
8	213.1	764.53	197.47	127.16	77.3	51.77	21.83	296.76	144.16		
9	134.3	172.64	185.62	79.35	56.18	11.87	17.02	252.89	18.8		
10	660.1	1113.3	616.11	218.48	56.18	12.82	4.83	77.53	18.8		
age/ year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**		
2	78.02	0.02	0.03	0.02	383.21	38.6	50.26	45.01	34.73		
3	82.68	139.88	30.41	133.81	342.35	57.72	97.46	78.46	88.41		
4	264.6	109.44	87.61	218.96	460.97	180.6	73.81	73.14	108.86		
5	343.2	97.85	249.87	145.97	374.86	335.75	86.93	122.41	133.97		
6	427.0	113.07	598.53	352.77	273.67	438.5	60.6	173.12	148.39		
7	197.3	154.38	329.84	279.78	687.42	141	43.06	185.6	101.34		
8	86.32	72.48	186.08	48.66	385.66	30.07	3.56	31.04	54.85		
9	20.32	30.44	38.05	24.33	198.22	3.51	0.77	1.74	6.16		
10	0.02	7.25	0.03	12.16	60.33	10.53	0.93	1.05	0.05		
age/ year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**		
2	95.16	192.51	174.81	96.98	60.94	10.74	64.23	19.91	37.79		
3	285.6	257.46	328.31	104.71	162.82	34.42	20.14	32.45	15.615		
4	292.4	348.84	623.2	234.67	182.62	119.65	18.11	53.63	56.66		
5	203.8	257.39	299.92	148.35	118.27	211.77	23.44	44.91	53.68		
6	97.92	157.26	153.74	99.48	68.3	177.26	10.05	15.78	21.42		
7	80.79	134.77	55.12	52.21	85.19	99.52	12.22	24.48	9.73		
8	53.54	25.72	7.24	18.05	13.97	46.42	13.94	15.04	5.07		
9	4.66	33.37	7.06	3	2.01	15.55	6.27	7.42	2.94		
10	1.5	0.04	0.76	1.15	0.02	3.83	1.88	1.94	0.3		
UKR	**Trawl**	**survey**	**East -**	**Configuration**							
BLACK	SEA	TURBOT	Total	2013	COMBSEX	TUNING	DATA(effort	nos at age).	Imported	from	VPA file.
min	max	plusgroup	minyear	maxyear	startf	endf					
2	10	10	1989	2006	0.75	0.83					
Index	type	:	number								
UKR	Trawl	survey	East	-	Index	Values					
Units	:	NA									

age/ year	1989	1990	1991	1992	1993	1994	1995	1996	1997
2	2.22	0.94	6.01	11.43	4.45	7.06	NA	NA	NA
3	6.21	1.69	2.8	14.95	8.74	13.87	NA	NA	NA
4	7.73	4.32	10.42	11.75	9.31	14.77	NA	NA	NA
5	11.15	4.55	13.21	10.31	16.92	26.85	NA	NA	NA
6	12.8	5.97	12.56	11.83	11.01	17.47	NA	NA	NA
7	6.53	6.48	6.96	8.71	10.53	16.7	NA	NA	NA
8	3.17	3.85	1.73	2	9.31	14.77	NA	NA	NA
9	2.98	2.87	1.79	1.68	7.93	12.59	NA	NA	NA
10	2.79	1.92	0.36	0.32	1.78	2.83	NA	NA	NA
year									
age/ year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
2	0.01	NA	NA	0.01	0.01	0.25	0.75	0.46	0.21
3	0.44	NA	NA	0.36	0.74	0.48	3.38	0.46	0.34
4	1.12	NA	NA	1.45	1.38	0.98	5.8	2.09	1.33
5	3.13	NA	NA	1.09	2.46	2.52	4.69	1.62	1.19
6	9.38	NA	NA	2.91	1.78	4	4.36	1.39	0.75
7	4.68	NA	NA	2.55	1.46	5.82	3.82	0.23	0.75
8	3.13	NA	NA	0.73	0.19	1.39	2.99	0.01	0.13
9	0.01	NA	NA	0.01	0.04	0.08	0.01	0.01	0.2
10	0.01	NA	NA	0.01	0.02	0.05	0.01	0.01	0.01

6.2.4.4 Results

STECF EWG 14-14 evaluated the Black Sea Turbot stock applying the state-space assessment model (SAM) (Nielsen et al., 2012). Version details and model configuration are listed below and are similar to those, used for the assessment for the period 1950 - 2012. In the new assessment, turbot spawning biomass was estimated at 1st of January.

Black Sea turbot STOCK OBJECT CONFIGURATION
min max plusgroup minyear maxyear minfbar maxfbar
2 10 10 1950 2013 4 8
Black Sea turbot sam CONFIGURATION SETTINGS
name : Final Assessment
desc :
range : min max plusgroup minyear maxyear minfbar maxfbar
range : 2 10 10 1950 2013 4 8
fleets : catch RO Trawl survey UKR Trawl survey West
fleets : 0 2 2
fleets : BG Trawl survey TR CPUE UKR Trawl survey East
fleets : 2 2 2
plus.group: TRUE
states :age
states : catch 1 2 3 4 5 6 7 7 7
states : RO Trawl survey NA NA NA NA NA NA NA NA NA
states : UKR Trawl survey West NA NA NA NA NA NA NA NA NA
states : BG Trawl survey NA NA NA NA NA NA NA NA NA
states : TR CPUE NA NA NA NA NA NA NA NA NA
states : UKR Trawl survey East NA NA NA NA NA NA NA NA NA

logN.vars : 1 2 2 2 2 2 2 2 2
catchabilities : age
catchabilities : fleet 2 3 4 5 6 7 8 9 10
catchabilities : catch NA NA NA NA NA NA NA NA NA
catchabilities : RO Trawl survey NA NA 3 3 3 3 4 5 NA
catchabilities : UKR Trawl survey West NA NA 6 7 8 9 10 11 12
catchabilities : BG Trawl survey20 21 22 23 24 24 NA NA NA
catchabilities : TR CPUE 1 25 26 27 28 29 30 31 2
catchabilities : UKR Trawl survey East 13 14 15 16 17 18 18 18 19
power.law.exps : age
power.law.exps : fleet 2 3 4 5 6 7 8 9 10
power.law.exps : catch NA NA NA NA NA NA NA NA NA
power.law.exps : RO Trawl surveyNA NA NA NA NA NA NA NA NA
power.law.exps : UKR Trawl survey West NA NA NA NA NA NA NA NA NA
power.law.exps : BG Trawl surveyNA NA NA NA NA NA NA NA NA
power.law.exps : TR CPUE NA NA NA NA NA NA NA NA
power.law.exps : UKR Trawl Survey East NA NA NA NA NA NA NA NA NA
f.vars : age
f.vars : fleet 2 3 4 5 6 7 8 9 10
f.vars : catch 1 2 2 2 2 2 2 2 2
f.vars : RO Trawl survey NA NA NA NA NA NA NA NA NA
f.vars : UKR Trawl survey West NA NA NA NA NA NA NA NA NA
f.vars : BG Trawl surveyNA NA NA NA NA NA NA NA NA
f.vars : TR CPUE NA NA NA NA NA NA NA NA
f.vars : UKR Trawl survey East NA NA NA NA NA NA NA NA
obs.vars : age
obs.vars : fleet 2 3 4 5 6 7 8 9 10
obs.vars : catch 1 2 3 4 5 6 7 7 8
obs.vars : RO Trawl surveyNA NA 9 9 10 10 11 12 NA
obs.vars : UKR Trawl survey West NA NA 13 14 14 15 16 17 18
obs.vars : BG Trawl survey26 27 28 29 30 31 NA NA NA
obs.vars : TR CPUE 32 33 34 35 36 37 37 37 38
obs.vars : UKR Trawl survey East 19 20 21 22 22 22 23 24 25
srr : 0
cor.F : FALSE
nohess : FALSE
timeout : 3600
Black Sea turbot FLR R SOFTWARE VERSIONS
FLSAM.version 0.99-9
FLCore.version 2.5.2000
R.version R version 2.15.0 (2012-03-30)
platform i386-pc-mingw32
run.date8.10.2014 11:25:56

SAM outputs and model diagnostics are listed in the tables below.

Table 6.2.4.4.1. Summary table of the final SAM model.

Year	Recruitment	Low	High	TSB	Low	High	SSB	Low	High	Fbar	Low	High	Landings	La SOP
1950	1975	1344	2903	16757	13935	20152	12666	10342	15513	0.4778	0.3494	0.6535	3932	1
1951	1907	1339	2717	16518	13951	19557	12664	10577	15163	0.5199	0.3992	0.677	4741	1
1952	1741	1217	2491	15639	13197	18532	12102	10116	14478	0.5725	0.4471	0.733	5217	1
1953	1908	1352	2693	14501	12215	17216	10970	9157	13141	0.6098	0.4807	0.7735	4985	1
1954	2054	1460	2891	13520	11384	16057	9831	8211	11771	0.6583	0.5221	0.83	4505	1

1955	1983	1398	2813	12729	10690	15156	8924	7464	10669	0.6883	0.5487	0.8634	3678	1
1956	1875	1319	2664	12215	10219	14601	8485	7092	10150	0.7288	0.5741	0.9251	3623	1
1957	1852	1308	2621	11919	9949	14279	8317	6928	9986	0.6293	0.4948	0.8004	3017	1
1958	1915	1365	2687	12047	10104	14365	8456	7064	10122	0.681	0.5441	0.8524	4289	1
1959	1776	1263	2498	11702	9857	13892	8204	6893	9764	0.7122	0.5651	0.8977	4653	1
1960	1684	1192	2378	11181	9427	13262	7838	6595	9314	0.6407	0.5054	0.8123	2680	1
1961	1641	1160	2322	11086	9366	13121	7901	6662	9369	0.6435	0.5067	0.8173	3058	1
1962	1625	1142	2311	11048	9340	13068	7931	6693	9398	0.6405	0.5036	0.8146	2904	1
1963	1730	1226	2441	11051	9338	13079	7871	6637	9334	0.6965	0.5532	0.8769	3812	1
1964	1632	1160	2295	10619	8958	12588	7480	6301	8880	0.6982	0.5529	0.8817	3666	1
1965	1922	1381	2675	10547	8903	12495	7184	6042	8542	0.6765	0.5304	0.8628	3063	1
1966	1980	1421	2758	10835	9146	12835	7260	6105	8633	0.677	0.5198	0.8816	3093	1
1967	2029	1455	2830	11302	9505	13437	7514	6293	8972	0.5822	0.4303	0.7877	2709	1
1968	1753	1259	2441	11851	9925	14151	8271	6884	9938	0.4952	0.3601	0.6811	2931	1
1969	1392	993	1952	12210	10152	14685	9096	7485	11053	0.427	0.3118	0.5847	3076	1
1970	1046	744	1470	12145	9971	14794	9670	7827	11948	0.499	0.3598	0.6921	5273	1
1971	847	602	1191	11035	8840	13774	9102	7149	11590	0.4114	0.2905	0.5827	3052	1
1972	914	657	1271	10434	8088	13461	8691	6546	11538	0.4181	0.2882	0.6064	3049	1
1973	995	722	1372	9790	7282	13161	7993	5683	11241	0.4497	0.2947	0.6863	3705	1
1974	1340	978	1836	9414	6758	13116	7230	4810	10868	0.3292	0.2058	0.5265	1696	1
1975	1498	1097	2045	10211	7311	14261	7623	4990	11644	0.2543	0.1612	0.4014	1273	1
1976	1614	1184	2201	11702	8532	16050	8746	5860	13054	0.228	0.1477	0.3519	1584	1
1977	1434	1058	1942	13178	9796	17728	10251	7124	14749	0.2292	0.1526	0.3443	2012	1
1978	1212	886	1658	14326	10815	18976	11671	8381	16253	0.2437	0.1689	0.3518	2160	1
1979	794	560	1124	14753	11178	19471	12689	9292	17328	0.3235	0.2336	0.448	5447	1
1980	442	295	662	13597	10254	18030	12195	8977	16567	0.2804	0.2037	0.3861	2843	1
1981	276	195	391	12455	9211	16843	11609	8442	15963	0.2961	0.218	0.402	3276	1
1982	209	151	289	10867	7801	15138	10340	7317	14612	0.3712	0.2822	0.4882	4662	1
1983	217	161	291	8691	5975	12640	8262	5577	12240	0.5132	0.374	0.7043	5307	1
1984	211	159	280	6343	4089	9839	5935	3716	9480	0.466	0.3218	0.6746	2852	1
1985	222	167	295	5025	3084	8187	4604	2705	7835	0.2307	0.1501	0.3545	527	1
1986	248	187	329	4725	2935	7609	4275	2529	7228	0.145	0.0906	0.2321	428	1
1987	279	208	374	4691	3033	7257	4191	2578	6813	0.2015	0.1466	0.2769	849	1
1988	321	235	439	4293	2948	6252	3724	2425	5719	0.2923	0.2247	0.3801	1116	1
1989	466	344	630	4055	2998	5484	3234	2237	4675	0.4401	0.3418	0.5668	1460	1
1990	728	542	978	3519	2830	4375	2560	1952	3358	0.533	0.4158	0.6833	1393	1
1991	1122	824	1527	3668	3105	4334	2208	1845	2643	0.5219	0.3983	0.684	935	1
1992	1351	972	1878	5505	4636	6537	3127	2657	3680	0.3541	0.2614	0.4796	439	1
1993	1325	939	1870	5762	4824	6883	3458	2929	4082	0.3622	0.2744	0.4781	1603	1
1994	1123	826	1525	6316	5326	7491	4380	3674	5222	0.593	0.4667	0.7536	2144	1
1995	926	688	1248	6606	5625	7758	5057	4247	6021	0.745	0.5874	0.9447	2943	1
1996	665	491	901	6292	5424	7299	4755	4033	5605	0.7715	0.6201	0.9599	2048	1
1997	693	504	955	5861	5070	6774	4453	3788	5235	0.6921	0.5504	0.8702	1025	1
1998	800	589	1087	6241	5411	7198	4664	4005	5432	0.589	0.4648	0.7464	1588	1
1999	756	560	1021	6156	5297	7154	4521	3851	5308	0.6208	0.4942	0.7798	1953	1
2000	653	481	887	5413	4608	6359	3929	3290	4691	1.036	0.8575	1.2516	2789	1

2001	592	441	795	4782	4097	5581	3450	2923	4072	1.2436	1.0468	1.4775	2557	1
2002	657	484	892	4315	3721	5004	3150	2698	3676	0.8351	0.6914	1.0086	1567	1
2003	871	651	1165	4189	3622	4844	2901	2504	3360	0.7505	0.619	0.9098	1122	1
2004	1225	908	1654	4940	4218	5787	2920	2520	3385	0.7922	0.6511	0.9639	1142	1
2005	1384	1004	1908	5507	4650	6522	3212	2758	3741	0.7588	0.6212	0.927	1400	1
2006	1359	974	1895	6957	5790	8360	4063	3446	4790	0.8573	0.711	1.0336	1751	1
2007	1112	791	1562	6657	5531	8012	4363	3672	5184	0.7466	0.6047	0.9218	2259	1
2008	882	620	1254	6088	5089	7282	4452	3743	5295	0.8291	0.6738	1.0203	2122	1
2009	722	499	1044	5515	4676	6505	4262	3616	5023	0.7124	0.5804	0.8745	2078	1
2010	590	403	864	4428	3718	5274	3390	2863	4013	0.7493	0.6124	0.9169	1738	1
2011	567	358	897	3595	2953	4377	2716	2252	3276	0.7911	0.6464	0.9681	1659	1
2012	496	265	928	3298	2598	4186	2493	1993	3119	1.0519	0.8533	1.2967	1714	1
2013	504	226	1128	2238	1576	3178	1634	1217	2194	1.3301	0.9247	1.9133	1522	1

Table 6.2.4.4.2. Black Sea turbot. Estimated fishing mortality.

age/year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
2	0.00919588	0.0110658	0.01396222	0.01345	0.0110139	0.0100308	0.010073	0.009295	0.011986	0.017705
3	0.0890551	0.092218	0.0968008	0.10162	0.1005299	0.1000886	0.1041941	0.111693	0.121347	0.125946
4	0.20276654	0.2125028	0.23013251	0.24766	0.2634478	0.2505241	0.2453671	0.263949	0.292293	0.30688
5	0.33844286	0.3741756	0.43129197	0.49616	0.5229706	0.568815	0.5042314	0.481042	0.516324	0.493906
6	0.40713926	0.4481353	0.51099269	0.56204	0.624209	0.6430261	0.7478297	0.660611	0.67134	0.712461
7	0.57604471	0.6450355	0.70799376	0.73104	0.7923992	0.8466228	0.880223	0.701279	0.857341	0.877621
8	0.86467635	0.9195379	0.98192731	1.012	1.08847	1.132548	1.266187	1.039743	1.067903	1.170288
9	0.86467635	0.9195379	0.98192731	1.012	1.08847	1.132548	1.266187	1.039743	1.067903	1.170288
10	0.86467635	0.9195379	0.98192731	1.012	1.08847	1.132548	1.266187	1.039743	1.067903	1.170288

age/year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
2	0.01534908	0.0074421	0.01026824	0.02074	0.0159771	0.0081772	0.0124991	0.02542	0.02244	0.02518
3	0.12642576	0.1287864	0.13302742	0.14084	0.1426302	0.139053	0.1279392	0.127009	0.123526	0.119194
4	0.28100017	0.2841651	0.28567514	0.28137	0.2864475	0.270739	0.256148	0.221995	0.21062	0.191111
5	0.4000803	0.3472536	0.34266568	0.38981	0.4121162	0.4244717	0.3884581	0.354304	0.312079	0.342529
6	0.63475892	0.5939204	0.55401141	0.64716	0.6661902	0.6213008	0.6877912	0.575964	0.534689	0.437885
7	0.73387248	0.7255248	0.73005895	0.88022	0.8583529	0.813947	0.8814914	0.732567	0.6457	0.600369
8	1.15392595	1.2665669	1.29015195	1.28383	1.2680496	1.251897	1.1709437	1.025957	0.773167	0.563138
9	1.15392595	1.2665669	1.29015195	1.28383	1.2680496	1.251897	1.1709437	1.025957	0.773167	0.563138
10	1.15392595	1.2665669	1.29015195	1.28383	1.2680496	1.251897	1.1709437	1.025957	0.773167	0.563138

age/year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	0.03951401	0.0037071	0.00249392	0.00295	0.0014513	0.0004258	0.0093227	0.013948	0.015475	0.007521
3	0.10955813	0.0919602	0.07857513	0.06285	0.0502573	0.0472738	0.0521464	0.056722	0.065271	0.07665
4	0.16821708	0.1518291	0.11177135	0.08562	0.0601448	0.0537023	0.0487281	0.047416	0.0532	0.062424
5	0.38090701	0.3352764	0.34687181	0.34425	0.2399319	0.2266836	0.1968132	0.165713	0.202503	0.248652
6	0.50486713	0.4549262	0.46421847	0.53	0.4425021	0.3690881	0.3004722	0.275574	0.264689	0.348158
7	0.81177668	0.6322123	0.70180478	0.85549	0.5839324	0.4144181	0.3861459	0.40417	0.431201	0.604581
8	0.62911576	0.4828786	0.46572032	0.43322	0.3194355	0.2078372	0.2076503	0.253194	0.267109	0.353667

9	0.62911576	0.4828786	0.46572032	0.43322	0.3194355	0.2078372	0.2076503	0.253194	0.267109	0.353667
10	0.62911576	0.4828786	0.46572032	0.43322	0.3194355	0.2078372	0.2076503	0.253194	0.267109	0.353667

age/year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	0.02498449	0.0293959	0.00069278	0.00037	0.0003083	0.0002664	0.000245	0.000251	0.000406	0.015708
3	0.08740524	0.1002789	0.10404831	0.08727	0.0560618	0.0310362	0.0204515	0.01977	0.021423	0.035091
4	0.06728621	0.0781442	0.10226375	0.11131	0.0849918	0.0480506	0.032906	0.037321	0.040567	0.078819
5	0.23868753	0.2429013	0.40098149	0.68092	0.3935135	0.1577411	0.1082513	0.125168	0.172804	0.260983
6	0.33220601	0.3260189	0.3902296	0.61575	0.7330144	0.2973338	0.2032741	0.30228	0.34342	0.485032
7	0.44506275	0.472877	0.57151188	0.76064	0.7851896	0.4691419	0.267162	0.259629	0.406985	0.616714
8	0.31898857	0.3603787	0.3908701	0.39747	0.3331375	0.1809924	0.1135627	0.283087	0.497525	0.759154
9	0.31898857	0.3603787	0.3908701	0.39747	0.3331375	0.1809924	0.1135627	0.283087	0.497525	0.759154
10	0.31898857	0.3603787	0.3908701	0.39747	0.3331375	0.1809924	0.1135627	0.283087	0.497525	0.759154

age/year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	0.06010874	0.0572573	0.04610195	0.19404	0.1184695	0.0642612	0.0208563	5.24E-05	2.10E-05	5.57E-05
3	0.05046375	0.0631148	0.06949503	0.08379	0.0905548	0.0863195	0.0846102	8.76E-02	8.10E-02	8.90E-02
4	0.13696909	0.1720277	0.17199326	0.18778	0.2133972	0.2335872	0.2015737	1.70E-01	1.69E-01	1.73E-01
5	0.38786808	0.4500755	0.31464823	0.31443	0.3618231	0.4521958	0.368697	2.27E-01	2.18E-01	2.66E-01
6	0.41083237	0.4147124	0.33380443	0.30703	0.3767739	0.5410411	0.6235165	4.30E-01	4.63E-01	4.79E-01
7	0.72996404	0.6243464	0.32332412	0.32091	0.5320595	0.7510223	0.6976345	5.79E-01	7.47E-01	1.17E+00
8	0.99927858	0.9485479	0.62646649	0.68086	1.481137	1.7469301	1.9661356	2.06E+00	1.35E+00	1.01E+00
9	0.99927858	0.9485479	0.62646649	0.68086	1.481137	1.7469301	1.9661356	2.06E+00	1.35E+00	1.01E+00
10	0.99927858	0.9485479	0.62646649	0.68086	1.481137	1.7469301	1.9661356	2.06E+00	1.35E+00	1.01E+00

age/year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2	0.0429508	0.0641071	0.1193017	0.03677	0.0219103	0.0384537	0.0682417	0.114876	0.163131	0.11067
3	0.1020696	0.1178315	0.1339887	0.13232	0.1297689	0.132192	0.1400438	0.15485	0.168133	0.178441
4	0.1796401	0.1965576	0.218144	0.21282	0.2221505	0.2391176	0.2516289	0.315941	0.35912	0.37677
5	0.2994523	0.3569713	0.3548004	0.34865	0.358653	0.3920954	0.3760926	0.390452	0.507383	0.565316
6	0.5980625	0.7895596	0.561283	0.55866	0.6260719	0.5506367	0.6021853	0.554294	0.480566	0.538423
7	2.0108349	2.5051535	1.3786986	1.18307	0.8195335	1.0122525	1.4626356	0.897116	0.958394	0.958524
8	2.0917688	2.3699527	1.6625624	1.44908	1.9346376	1.6001222	1.5938461	1.575212	1.8401	1.123052
9	2.0917688	2.3699527	1.6625624	1.44908	1.9346376	1.6001222	1.5938461	1.575212	1.8401	1.123052
10	2.0917688	2.3699527	1.6625624	1.44908	1.9346376	1.6001222	1.5938461	1.575212	1.8401	1.123052

age/year	2010	2011	2012	2013
2	0.03828106	0.309128	0.2110416	0.29879
3	0.16506763	0.1744355	0.184243	0.18684
4	0.36677746	0.3331042	0.3805567	0.43184
5	0.66319912	0.6988494	0.6997725	0.88913
6	0.63161831	0.5630201	0.6845319	0.83332
7	0.90733005	0.8500586	1.5021989	1.44249
8	1.17769601	1.5104083	1.99244	3.05384
9	1.17769601	1.5104083	1.99244	3.05384
10	1.17769601	1.5104083	1.99244	3.05384

Table 6.2.4.4.3. Black Sea turbot. Estimated population abundance.

age/ year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
2	1975.15074	1907.407	1741.32222	1908.17	2054.3197	1982.8689	1874.8801	1851.775	1915.052	1776.322
3	2020.90357	1748.6512	1686.48203	1522.49	1680.7577	1819.651	1753.0283	1653.583	1634.84	1694.766
4	1622.29972	1657.0596	1430.52959	1373.75	1223.7804	1362.3957	1481.0403	1416.579	1323.189	1294.656
5	1231.63767	1189.8708	1203.87404	1021.17	963.81561	838.23627	952.69994	1045.134	977.9905	885.188
6	790.60621	790.13198	736.27228	703.171	558.35781	513.93665	423.6044	517.8574	583.1824	523.952
7	439.3516	473.94913	454.63732	397.343	360.71927	268.67434	243.52023	179.1637	241.2177	268.8087
8	220.65491	222.47172	223.74343	201.442	172.15582	146.89235	103.54435	90.63133	80.09392	91.95506
9	77.0535	83.72185	79.9259	75.4673	65.9568	52.20091	42.64884	26.21679	28.85837	24.8138
10	48.87177	47.76055	47.20029	42.8712	38.72944	31.73436	24.34679	16.99297	13.75634	13.19582

age/ year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
2	1683.61745	1641.228	1624.57253	1729.69	1631.8996	1922.1507	1979.6988	2029.206	1752.853	1392.144
3	1555.41862	1477.3423	1454.0383	1431.53	1516.7118	1421.9721	1710.4299	1745.157	1774.191	1533.948
4	1342.24652	1226.9663	1162.35105	1141.05	1110.9825	1180.862	1099.818	1356.279	1376.914	1410.783
5	852.01148	913.05854	828.403206	783.288	773.7896	746.50327	809.97226	758.5434	981.2232	1000.545
6	483.76536	512.44839	582.308281	529.271	475.75357	460.58619	437.11661	494.0319	475.5158	650.4731
7	230.51133	230.37306	254.296269	302.657	249.03663	219.31302	223.09552	196.5663	250.31	249.2858
8	100.41384	99.61373	100.263328	110.421	112.87714	94.878773	87.46161	82.93026	84.81734	118.2499
9	25.64888	28.50843	25.272074	24.8287	27.538912	28.576937	24.39797	24.39065	26.69296	35.14211
10	10.62383	10.30573	9.844373	8.70415	8.363692	9.102053	9.7046	9.523858	10.94409	15.64576

age/ year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	1045.76087	846.83003	913.51519	995.156	1339.6987	1497.5714	1614.2085	1433.824	1211.967	793.6956
3	1213.90777	892.8334	746.57793	813.137	878.39818	1200.748	1341.7097	1433.537	1263.448	1073.415
4	1221.94606	974.96347	726.76269	612.838	684.09719	744.78829	1034.7343	1145.504	1219.749	1062.203
5	1049.42744	928.89899	749.57022	581.726	500.14597	580.6801	630.9332	892.8334	986.8322	1044.193
6	638.03938	643.42148	599.20274	474.803	367.78554	352.55266	416.75562	463.7752	689.2472	727.9992
7	381.38143	345.15721	367.52818	340.155	249.8848	211.51586	218.74354	278.495	315.9551	483.2335
8	123.28515	151.98776	165.42204	164.12	129.37304	124.99828	125.80084	133.7403	167.6201	185.0822
9	60.81886	59.08045	84.44496	93.5691	95.68868	84.14151	91.26798	92.23134	93.46621	116.0243
10	26.09125	41.73333	56.06995	79.4955	101.05854	128.62485	155.78861	180.9463	191.0624	196.4288

age/ year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	441.6863	275.8342	208.951	216.589	210.7558	221.84967	248.14171	278.8015	321.308	465.634
3	707.8272	382.6038	236.7489	184.749	193.6592	187.48522	197.49238	221.34	248.7628	285.2312
4	896.7705	584.8176	308.2157	188.84	149.8298	164.00551	162.89405	174.1645	195.0196	221.0082
5	895.8742	758.4675	489.4587	247.671	149.1422	121.53472	140.75207	142.8079	151.0182	171.2629
6	732.1607	634.6667	541.91	296.219	110.6199	88.92559	92.78639	114.8125	114.3198	114.2741
7	461.7391	472.813	413.5589	334.354	143.8542	46.75401	59.14547	68.66915	76.44718	73.49372

8	237.4602	267.3343	265.6554	210.756	140.9775	58.59797	25.9248	40.92741	48.22608	45.6544
9	116.8861	155.6952	168.3929	162.26	127.7787	90.82186	43.80728	20.96805	27.76288	26.42472
10	197.7097	206.211	227.6706	241.483	244.3252	239.82272	248.19134	234.3463	172.9323	109.5521

age/ year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	727.92644	1121.9236	1350.72937	1325.31	1122.597	926.39434	665.00862	693.3951	800.1506	755.9687
3	406.58784	610.57431	951.08173	1158.06	975.15848	888.64693	777.74601	571.5775	620.1739	722.6319
4	243.66638	342.47546	509.535741	798.871	955.18019	792.66446	728.87336	643.3571	461.0009	516.9261
5	183.77276	187.16676	253.331777	382.604	599.80224	693.88067	556.18446	533.8954	491.5187	347.1649
6	119.21159	112.2468	104.470005	164.811	250.86125	378.94838	393.11414	341.2448	385.5612	361.8754
7	62.30863	71.87295	66.30067	65.9041	109.36599	155.96007	198.46247	187.2791	199.4772	218.8529
8	35.66608	26.66628	34.55665	43.4539	42.80693	57.714013	65.937017	88.76567	94.46222	85.41314
9	19.24016	11.80237	9.234994	16.7166	20.03739	8.641706	9.098413	8.291244	10.3047	22.10271
10	57.13975	25.20393	12.886754	10.6814	12.54598	6.637929	2.372395	1.447387	1.109157	2.677624

age/ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2	653.210869	591.75932	656.879111	871.225	1225.2498	1383.6774	1358.7222	1111.872	881.6543	721.6209
3	680.957571	536.94733	477.23069	501.147	724.80308	1044.4023	1155.9757	1100.918	855.683	644.4518
4	599.32259	538.99161	413.683008	360.972	380.77171	553.57653	803.92019	879.0133	820.8989	628.4145
5	393.428756	441.28901	389.085845	288.934	256.28754	266.82686	383.94526	553.2998	554.8512	498.5481
6	237.79287	256.54395	271.809105	239.703	178.23448	156.5695	157.52749	230.6958	331.3913	290.9059
7	204.465652	114.17131	102.380882	137.538	119.92901	82.244786	79.495467	75.11348	116.1172	181.7442
8	60.946718	23.924427	8.139266	22.7258	36.708194	46.669927	26.117354	15.96342	26.87241	39.07567
9	28.303911	6.535181	1.9595797	1.35016	4.6926619	4.5960627	8.344478	4.67206	2.895333	3.752041
10	8.134384	3.957846	0.8653943	0.47278	0.3741869	0.6440751	0.9192961	1.651114	1.148458	0.560655

age/ year	2010	2011	2012	2013
2	589.809734	566.51298	496.309637	504.466
3	558.581201	490.97833	359.315201	346.61
4	465.354742	415.83976	360.03455	260.447
5	376.004082	280.75994	262.906906	215.185
6	247.794556	168.88196	121.413248	114.514
7	148.309306	115.22653	84.52945	53.4582
8	61.301236	52.87338	43.384403	16.4825
9	11.22339	16.643171	10.311915	5.2174
10	1.235703	3.375016	3.882969	1.69786

Table 6.2.4.4.4. Black Sea turbot. Predicted catch numbers at age.

age/ year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
2	17.08891	19.84039	22.8212	24.0913	21.26729	18.70554	17.75967	16.19269	21.56669	29.46903
3	163.18753	145.99319	147.47962	139.435	152.35906	164.2747	164.40946	165.6455	177.1027	190.1437
4	282.74346	301.28902	279.32333	286.306	269.29569	286.83582	306.13617	312.2706	318.7159	325.1901
5	336.39969	353.40687	401.50099	380.467	373.96417	346.59259	359.42661	380.1097	375.7447	328.6456
6	251.7836	271.84444	280.75713	288.282	247.33409	232.58366	213.04001	238.9203	272.1545	254.8946

7	183.47162	214.96603	220.22726	196.761	188.59088	146.67364	136.28387	86.21636	132.7463	150.1568
8	122.15125	127.99869	133.95983	122.777	109.41194	95.43258	71.34591	56.11538	50.35662	60.81339
9	42.65438	48.16632	47.85377	45.9986	41.91652	33.91475	29.3884	16.23225	18.14418	16.409
10	27.05279	27.47894	28.26092	26.1312	24.61387	20.61605	16.77685	10.52107	8.648535	8.726462

age/year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
2	24.241111	11.502104	15.685238	33.5578	24.44975	14.795454	23.244534	48.14802	36.77065	32.72633
3	175.135507	169.24883	171.705363	178.322	191.15794	175.02871	194.72533	197.3522	195.4511	163.3949
4	312.467355	288.41488	274.488674	265.929	262.96738	266.12603	236.13413	256.4644	248.3329	233.0307
5	267.385116	254.82321	228.622003	240.635	248.76533	245.8029	248.10946	215.2973	250.1448	276.0191
6	216.902946	218.89015	236.157747	240.64	220.82488	203.32994	207.50802	206.2853	187.7329	219.6884
7	114.453657	113.48946	125.813418	169.378	137.15751	116.71207	124.96079	97.47832	113.6212	107.3345
8	65.900762	68.648549	69.7446	76.6209	77.83335	64.998877	57.8579	50.9518	43.64506	48.56971
9	16.834494	19.647498	17.579439	17.2284	18.99014	19.576894	16.139667	14.9853	13.736	14.43492
10	6.972822	7.102522	6.847407	6.03937	5.76745	6.235383	6.419884	5.851511	5.631523	6.426757

age/year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	38.30575	2.961719	2.150656	2.76757	1.836246	0.602513	14.15857	18.77226	17.59351	5.621396
3	119.40487	74.345266	53.46194	46.9311	40.789716	52.528191	64.59003	74.89147	75.64339	75.05116
4	179.60859	130.35872	72.921973	47.7057	37.874195	36.929844	46.66619	50.30528	59.92897	60.965
5	316.30597	251.68794	209.009562	161.173	101.4007	111.91952	107.08362	129.5051	171.8686	218.4812
6	241.061	224.02329	212.00079	186.2	125.26732	103.58267	102.89818	106.2559	152.4414	203.6963
7	202.59725	154.30636	176.939878	186.937	105.40499	68.338958	66.71034	88.16235	105.4039	209.1371
8	54.9443	55.492618	58.702364	54.9844	33.675818	22.307434	22.43293	28.46229	37.38576	52.50036
9	27.10613	21.571435	29.967097	31.3467	24.908024	15.017107	16.27435	19.62747	20.84637	32.91044
10	11.62863	15.236441	19.896822	26.6314	26.306078	22.956015	27.77955	38.507	42.61388	55.72005

age/year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	10.30254	7.55387	0.1367583	0.07499	0.0614102	0.0558531	0.0574627	0.066017	0.123415	6.8594
3	56.14401	34.59918	22.1762079	14.6314	10.00365	5.4272904	3.7867192	4.103909	4.994114	9.316528
4	55.34797	41.70037	28.4258801	18.876	11.58128	7.2962462	4.9996605	6.049647	7.351983	15.88873
5	180.78166	155.45558	153.877988	116.698	46.174145	16.842408	13.708554	15.95129	22.7624	37.39586
6	196.94608	168.02453	166.695701	129.92	54.882251	21.758185	16.223325	28.49418	31.6238	41.84825
7	157.99762	169.73527	171.688193	170.092	74.756787	16.680661	13.188563	14.93145	24.33876	32.26942
8	61.7337	77.03193	81.8648732	65.8487	38.028657	9.2236423	2.6444709	9.602371	18.02194	23.20552
9	30.38989	44.8633	51.8922784	50.6956	34.468643	14.296718	4.4688898	4.919712	10.37511	13.4316
10	51.40266	59.42054	70.1615191	75.45	65.909329	37.754324	25.320137	54.99543	64.64172	55.70333

age/year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	40.15994	59.037333	57.540555	221.34	118.67516	54.527764	12.974683	0.034347	0.015852	0.039766
3	18.95542	35.384363	60.502216	88.2188	80.015471	69.640758	59.798465	45.42488	45.73528	58.2958
4	29.60076	51.388787	76.440297	129.863	174.33173	156.84531	126.35305	95.26	68.1179	77.83024
5	56.22267	64.586796	65.035937	98.167	173.24383	240.3437	163.18426	102.961	91.42509	77.10746
6	38.24642	36.287016	28.215458	41.4538	74.969398	150.96379	173.99734	113.6462	136.1041	131.2049
7	30.8242	31.844032	17.427162	17.2138	43.017198	78.666705	95.151466	78.46087	100.2022	144.8922
8	21.57791	15.636845	15.355596	20.4901	31.78899	45.904355	54.709097	74.72091	67.14873	52.07682

9	11.63991	6.920929	4.103212	7.88254	14.880922	6.871896	7.547754	6.977077	7.325197	13.47802
10	34.58016	14.782145	5.726474	5.03725	9.317366	5.279017	1.967849	1.217838	0.788227	1.632617

age/year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2	25.564125	34.215885	68.8369042	29.2766	24.712026	48.584765	83.465219	112.4265	123.7211	70.43709
3	61.760253	55.800342	55.956802	58.0799	82.480343	120.93098	141.25687	147.7128	123.8722	98.52989
4	92.333775	90.129723	75.9959462	64.8547	71.103033	110.37349	167.68714	223.4304	232.5209	185.234
5	95.601642	124.47688	109.198792	79.9115	72.578592	81.357254	113.10878	168.1187	207.8112	202.7553
6	100.882856	132.28517	109.99336	96.6649	78.188298	62.450235	67.170892	92.47978	119.0222	114.0754
7	169.367346	100.69237	72.8068468	90.5109	63.403559	49.586073	58.114779	42.08368	67.75715	106.069
8	51.137087	20.810757	6.2896788	16.5494	30.023788	35.499549	19.834047	12.0626	21.59475	25.01036
9	23.761105	5.687097	1.5148357	0.98353	3.8393766	3.496946	6.3388033	3.531561	2.327019	2.402106
10	6.829695	3.445159	0.6691199	0.34444	0.3061408	0.490069	0.6982459	1.247876	0.922911	0.35885

age/year	2010	2011	2012	2013
2	20.619351	140.69578	88.084801	121.677
3	79.503417	73.520185	56.564976	55.2716
4	134.142142	110.55576	107.002265	85.8121
5	171.861686	133.14916	124.798446	119.779
6	109.402091	68.502483	56.778629	61.18
7	83.683347	62.384073	62.541479	38.8341
8	40.263687	39.229539	35.840194	15.1514
9	7.373777	12.352889	8.520542	4.79681
10	0.811745	2.504768	3.208553	1.56089

Table 6.2.4.4.5. Black Sea turbot. Catch at age residuals.

age/ year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
2	-0.0464185	-0.005239	0.0420497	0.04691	-0.014099	-0.024002	0.0175855	-0.096294	-0.020905	0.139701
3	-0.296267	-0.057211	0.0898356	0.19135	-0.030889	-0.195961	-0.208514	-0.194658	0.30665	0.503828
4	-0.284194	-0.153861	0.149024	0.21438	0.0670665	-0.128464	-0.213744	-0.065186	0.197461	0.595234
5	-0.332588	-0.084216	0.0832666	0.3596	0.0118773	-0.05504	-0.148251	0.033819	0.472414	0.367829
6	-0.2456	0.0068524	0.167578	0.02386	0.12706	-0.183287	-0.0169538	-0.18735	0.296039	0.320235
7	-0.106045	0.0642223	0.105677	-0.0358	0.0307501	-0.02887	0.306811	-0.610867	0.251515	0.284124
8	-0.110607	0.151184	0.068076	-0.116	0.111413	-0.178815	0.330617	-0.565669	0.236704	0.112356
9	-0.0292244	0.0933454	0.182908	0.032	0.123824	0.0506926	0.287366	-0.545959	-0.002269	0.143544
10	-0.0440878	0.0901769	0.0687296	-0.0156	0.0369384	-0.053643	0.0945674	-0.402686	-0.009728	0.192348

age/ year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
2	0.152292	-0.28613	-0.11282	0.29127	0.0674835	-0.284327	-0.0767971	0.27814	-0.041807	-0.073386
3	-0.189203	-0.200266	-0.188598	0.22469	0.535672	-0.026513	-0.309826	0.194517	0.362916	0.57541
4	-0.320582	-0.03596	0.0261133	-0.132	0.182814	0.197812	-0.143923	-0.09008	0.267771	0.472304
5	-0.476837	-0.187767	-0.512778	0.16175	0.157899	0.137777	0.135122	-0.370213	-0.368707	-0.089368
6	-0.389141	-0.098403	-0.202449	0.4289	0.071494	-0.37442	0.300539	-0.156245	-0.112564	-0.368903
7	-0.239765	-0.056403	-0.186413	0.4031	-0.007668	-0.196974	0.314755	-0.24837	0.018512	-0.506187
8	-0.230334	0.182067	0.0724957	0.38672	0.109585	0.11418	0.372833	0.107734	0.224112	-0.328393

9	-0.41468	0.0394604	-0.0351009	-0.1813	-0.091266	-0.215735	-0.316724	-0.223495	-0.625005	-0.949281
10	0.229736	0.346207	-0.232054	0.09283	0.0330737	0.299974	0.18482	0.207829	-0.101423	-0.130075

age/ year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	0.718709	-0.550517	-0.154031	0.23112	0.14482	-1.17827	0.752137	0.089579	0.272234	-0.508264
3	0.874211	-0.353132	0.248823	0.00467	-1.60104	-1.24325	0.237116	-0.360656	-0.128732	0.547422
4	-0.0463333	1.28466	-0.406942	0.28258	-1.55554	-0.198214	-0.305025	-0.859034	-0.189632	0.590733
5	0.97814	-0.412417	-0.0580539	0.98835	-1.5075	0.483565	-0.0567626	-1.02991	0.238979	1.1326
6	0.58104	-0.39463	-0.0289498	0.55679	-0.454661	-0.085659	-0.229406	-0.292572	-0.291721	1.11633
7	0.852658	-0.441459	-0.0498862	0.64025	-0.218593	-0.38599	-0.169478	0.057277	-0.329527	1.08805
8	0.781999	-0.5093	0.389289	0.6393	0.128131	-0.247697	-0.295235	0.070756	-0.372889	0.731124
9	0.63555	-0.452046	-0.109495	0.16429	-0.215593	-1.34688	-0.458487	0.4278	-0.15046	0.834811
10	0.991231	0.0156401	0.370026	0.48285	0.325081	-0.647863	0.167066	0.401497	-0.22045	0.513188

age/ year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	0.244974	0.983967	-0.852703	-0.1266	-0.007527	-0.017287	-0.0289522	-0.126187	-0.867488	0.609564
3	0.242464	0.626115	1.3311	1.91487	1.35407	-1.56491	-3.39034	-0.999422	-3.59877	1.01881
4	-0.313375	-0.58294	0.954727	1.76613	1.55191	-1.2559	-3.3165	0.337231	-3.71881	1.0162
5	-0.196318	-1.31031	0.496408	2.134	-0.016405	-2.47202	-1.8636	-0.431463	-0.279534	0.843295
6	-0.0417702	-0.477661	0.0640027	1.12525	0.725635	-2.16061	-2.3608	1.17879	-0.154447	1.1148
7	-0.392487	-0.103307	0.0228344	0.71235	0.445661	-0.531188	-0.650874	-0.402605	0.027994	0.425896
8	-0.414381	0.308315	-0.116253	0.30425	1.02601	-0.453087	-4.55855	0.647984	1.38885	-0.590643
9	-0.327226	0.240337	0.575601	0.61717	0.524255	-0.295217	-1.01556	1.03172	-0.342423	0.306505
10	0.00910828	0.264206	0.628647	0.53582	0.473331	-0.2559	0.152525	-0.205562	-0.117201	-0.044379

age/ year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	0.369572	0.201823	-0.335633	0.76249	0.0385788	0.23439	1.21836	-1.38567	-0.517346	-1.55016
3	1.02946	0.987614	-0.587818	1.14529	1.01899	-0.315724	-0.30981	0.254307	-1.31232	0.145378
4	1.34883	0.569459	-1.01231	0.15938	0.270718	0.732448	0.0319422	-0.715408	-1.03729	0.410269
5	0.948226	-0.123046	-2.42592	-0.7937	0.306883	1.28599	0.0624326	-1.56896	-0.397045	-0.021846
6	-0.0751055	0.593055	-1.69088	-1.0757	-0.399072	1.12338	0.431751	-1.86156	0.590417	0.775124
7	-0.307483	0.76945	-0.790111	-0.9078	0.217495	0.582371	0.117323	-0.761569	-0.182197	0.045212
8	-0.0749577	-1.14737	-0.811852	-0.6145	0.402427	-1.65728	-0.468159	-1.55241	-0.37679	-1.32843
9	0.194457	-0.229943	-1.09435	0.69245	1.51071	-1.9125	0.520283	1.2293	0.785476	-0.110294
10	0.022647	-0.686881	-0.659368	-0.3411	0.0797183	-0.598944	-4.03403	0.758379	-3.39658	1.05627

age/ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2	1.64027	-0.208186	0.225772	-0.2027	-0.232977	0.0615497	0.134196	0.048433	0.046547	0.195906
3	0.374802	-0.218833	0.861271	-0.2493	-0.384825	0.194484	-0.0932785	0.322135	0.094114	0.660952
4	0.385744	0.415602	0.519474	-0.5237	-0.130062	0.381118	0.0173947	0.670109	0.314233	0.32574
5	0.218335	1.25271	0.52477	-0.3361	0.119102	0.548918	0.193465	0.32953	-0.095002	-0.401236
6	-0.569019	2.0416	-0.184202	-0.0636	0.212754	-0.383683	0.307466	0.251585	0.241799	-0.443091
7	0.890217	0.177738	-0.0560397	0.62113	-0.454462	-0.746993	0.721615	-0.741534	0.140919	0.577377
8	1.43134	0.114709	-0.098362	0.03396	0.101609	-0.382299	-0.844048	-1.681	0.195523	-0.486971
9	1.61795	-1.45936	-0.28864	-0.07	-0.139762	-0.611984	1.74781	0.543261	0.996116	0.257602

10	0.724789	0.630837	0.65635	0.38904	-1.86025	0.389849	-2.84516	-0.698975	0.390088	-1.95651

age/ year	**2010**	**2011**	**2012**	**2013**
2	-0.892794	0.830177	-0.465077	0.12369
3	-0.788025	0.184025	0.415886	0.03211
4	-0.274186	-0.305116	0.407866	0.94475
5	0.121217	-0.389999	0.0925941	1.04625
6	0.778081	-0.906424	-0.474404	0.76296
7	0.178739	-0.61764	0.777457	-0.1608
8	-0.00039187	0.904324	0.37854	0.34171
9	1.11728	1.56481	1.72795	1.463
10	1.09572	0.960398	0.443648	-0.2644

Table 6.2.4.4.6. Black Sea turbot. Predicted index at age (TR CPUE).

age/year	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
2	11.84801	13.65315	19.63434	30.0211	46.33557	56.09631	51.11817	44.9666	38.12728
3	42.79366	48.05662	54.72496	77.4095	115.51727	179.3627	216.84656	181.9824	166.1764
4	73.66885	82.36083	91.56234	98.0591	135.43746	201.50415	313.44378	369.9952	303.9429
5	104.15915	107.5569	116.72024	117.54	116.04639	168.07831	253.8821	388.6814	429.7785
6	108.04848	105.39024	98.14736	106.262	99.85808	96.77609	154.72665	227.4431	316.5053
7	108.9196	112.64711	97.50952	78.1211	95.00505	101.86618	101.38042	151.3947	193.5024
8	94.24427	99.75728	82.85483	57.4038	44.01938	67.01926	82.00416	54.14036	63.9173
9	67.23877	79.97227	66.78176	43.1206	27.13081	24.93793	43.93055	35.29213	13.32431
10	355.71505	235.80849	131.07242	60.6264	27.42404	16.47098	13.28586	10.45772	4.84419

age/year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
2	27.968811	29.467855	34.0067828	32.1281	26.73945	23.968728	25.884129	35.77574	50.68804
3	145.574794	106.82265	116.291504	134.967	124.52793	97.426671	85.889364	90.27134	130.7216
4	284.001636	254.7162	182.558378	204.355	232.82568	207.62011	157.64095	137.9126	144.8125
5	359.167912	370.0951	342.266612	235.976	259.49567	282.80568	249.62755	185.943	164.1072
6	315.059024	301.20467	334.832364	311.759	190.42149	186.6845	221.70108	195.7836	140.7394
7	252.891363	253.28112	248.027593	219.781	133.37571	58.162452	91.606296	135.7018	141.9209
8	65.439104	84.277085	127.689304	136.569	56.072753	19.152438	9.2809137	28.83241	36.53205
9	12.571722	10.958331	19.3974187	49.22	36.287742	7.289755	3.1131031	2.38641	6.506424
10	1.551214	0.905229	0.9878044	2.82162	4.936221	2.089931	0.6507746	0.395517	0.245529

age/year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2	56.7678418	54.924527	43.906835	33.9857	28.557512	24.200662	20.301403	18.68012	18.17124
3	188.136921	207.41466	196.087306	151.398	113.43954	98.983186	86.591356	63.06273	60.75504
4	208.748463	301.25588	318.96456	291.523	221.20282	164.62004	149.60373	126.4883	89.18831
5	168.029574	243.71512	348.702806	329.834	287.90196	206.76234	151.65376	141.945	105.6857
6	128.38711	125.89019	188.826764	281.423	240.00266	195.12688	137.6329	93.11823	81.52828
7	88.3874508	68.206509	85.513136	128.192	200.64356	167.97749	134.29649	71.10517	46.33279
8	54.9003652	30.820807	19.013704	28.0391	58.353539	89.078678	65.052849	41.94755	9.373251
9	7.5318448	13.71829	7.752768	4.20809	7.8052767	22.719646	28.528968	13.88932	4.133316

10	0.4995398	0.7151528	1.296458	0.78985	0.5518334	1.183674	2.737678	2.475249	0.636524

Table 6.2.4.4.7. Black Sea turbot. Index at age, residuals (TR CPUE).

age/year	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	-0.878786	-0.856849	0.671119	0.83711	0.907911	0.474781	0.873519	1.03887	0.896373
3	-0.65232	-2.9227	1.5246	1.3146	1.7634	-0.127212	0.716848	1.91805	0.606391
4	0.501449	-2.56929	1.47213	1.66624	1.58013	-0.233185	-0.298081	1.34504	1.83017
5	0.614647	1.2463	1.72269	1.54125	1.51085	-0.602948	-0.955178	1.32884	2.0889
6	1.61579	1.44335	1.75258	0.63531	1.22552	-0.265555	-1.16409	0.612235	1.49799
7	0.692322	1.46911	1.42788	0.83081	1.25799	-0.248203	-1.53418	0.795379	1.24055
8	0.815511	2.03585	0.868207	0.79508	0.56288	-0.258081	-1.32305	1.70078	0.813065
9	0.69182	0.769272	1.02193	0.60967	0.727656	-0.742127	-0.947905	1.96865	0.344157
10	0.333661	0.837687	0.835311	0.6919	0.387053	-0.135252	-0.546119	1.08123	0.731904

age/year	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0.352772	-2.50867	-2.41851	-2.5384	0.915545	0.163856	0.228187	0.078957	-0.130014
3	-0.440887	0.210124	-1.04537	-0.0067	0.78816	-0.407986	0.0984933	-0.109287	-0.304796
4	-0.0628655	-0.748906	-0.650855	0.0612	0.605527	-0.123603	-0.672712	-0.562272	-0.252988
5	-0.0440508	-1.28441	-0.303788	-0.4637	0.355116	0.165679	-1.01846	-0.403638	-0.195901
6	0.254345	-0.819497	0.485818	0.10337	0.303353	0.714237	-1.08484	-0.1029	0.04427
7	-0.247997	-0.494919	0.284975	0.2413	1.63924	0.885232	-0.754652	0.313032	-0.336679
8	0.276854	-0.150748	0.376453	-1.0316	1.92767	0.450947	-0.957887	0.073753	0.406274
9	0.479993	1.02132	0.673544	-0.7044	1.69734	-0.73061	-1.39652	-0.315801	-0.054697
10	-2.34835	1.12292	-1.88594	0.78845	1.35104	0.872779	0.192691	0.526956	-0.858907

age/year	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	0.177641	0.431284	0.475106	0.36057	0.260645	-0.279364	0.396066	0.021928	0.251787
3	0.325183	0.168454	0.401674	-0.2874	0.281636	-0.823238	-1.13668	-0.517825	-1.05885
4	0.298845	0.130009	0.593779	-0.1923	-0.16992	-0.28286	-1.8719	-0.760663	-0.402195
5	0.186292	0.052709	-0.145506	-0.7714	-0.858944	0.0231049	-1.8027	-1.11106	-0.654042
6	-0.226579	0.186092	-0.17194	-0.8698	-1.05114	-0.080325	-2.18888	-1.48472	-1.11796
7	-0.0898471	0.68081	-0.439011	-0.898	-0.856366	-0.523302	-2.39618	-1.06595	-1.56012
8	-0.0250836	-0.180857	-0.965225	-0.4403	-1.42914	-0.65158	-1.53993	-1.02537	-0.614318
9	-0.479967	0.888633	-0.093574	-0.3383	-1.35622	-0.379046	-1.51464	-0.62673	-0.340554
10	0.59344	-1.55634	-0.28825	0.20276	-1.79053	0.633762	-0.202848	-0.131504	-0.405999

Table 6.2.4.4.8. Black Sea turbot. Predicted index at age (Ukr Trawl suvey West)

age/year	1989	1990	1991	1992	1993	1994	1998
5	30.14021	29.25528	28.367099	42.7317	64.550638	97.475396	89.493858
6	30.26313	33.47805	31.425196	31.1782	50.236909	72.367695	103.90947
7	39.16525	30.36407	38.075461	44.5495	44.367623	62.320474	95.940672
8	29.92308	19.33661	15.047622	25.1531	30.295828	15.858569	38.872226
9	36.95386	22.25552	14.210342	14.3407	24.867208	15.839392	9.0477852

10	29.10151	12.55501	5.763356	3.80041	3.017534	1.883203	0.1848723
age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
4	42.0100972	31.698203	27.7742685	29.0849	41.720391	59.991327	62.343536
5	70.4695006	62.240754	46.445055	40.8718	41.4447	60.392203	86.049267
6	52.2865935	66.343779	58.6325498	41.3325	38.538202	37.228329	56.621003
7	13.4085156	29.277813	45.9025192	53.3439	31.416398	21.27473	31.426768
8	4.3029464	2.5598765	8.46043	9.31168	15.418992	8.6718314	5.378718
9	2.5101337	1.31602	1.07324922	2.54178	3.2420959	5.9158193	3.361341
10	0.2887454	0.1103818	0.07137055	0.03849	0.0862763	0.1237403	0.225535

Table 6.2.4.4.9. Black Sea turbot. Index at age, residuals (Ukr Trawl suvey West).

age/year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1998**
4	0.38711	-0.684889	0.60621	-0.1431	-1.2176	-1.52819	-1.0329
5	0.368809	-1.62146	0.0993695	-0.5495	-0.411637	-1.39133	-1.03404
6	0.658205	-1.32735	-0.18879	0.42994	-0.798898	-1.67661	0.363798
7	-0.85346	-0.590202	-0.77151	-0.6315	-0.394637	-0.91229	-0.422439
8	-0.983272	-0.4577	-1.06219	-1.2419	-0.028226	0.523494	-0.0421905
9	-1.29005	-0.893694	-1.17487	-0.9304	0.0062181	0.397067	0.183522
10	-0.586079	-0.380071	-0.922074	-0.6483	0.308815	0.523101	-1.44854
age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
4	0.580282	0.717211	-0.258698	0.71413	-1.07163	1.68307	1.40806
5	0.211394	0.792613	0.572523	0.83912	0.186274	1.39126	0.745561
6	-1.79151	-0.04561	1.06685	1.66041	0.527705	1.40697	0.0087372
7	-1.46494	0.811544	1.51456	0.91595	1.50843	1.17597	0.315302
8	-1.71897	0.887175	1.24447	1.34455	1.37813	-0.088241	0.472199
9	-1.28713	0.111869	0.528953	1.54374	1.36665	0.51803	1.21706
10	0.40293	1.03648	1.36716	-0.6692	1.79892	-1.24918	0.865985

Table 6.2.4.4.10. Black Sea turbot. Predicted index at age (Ukr Trawl suvey East).

age/year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1998**
2	0.2456518	0.3708016	0.5727821	0.69569	0.6073239	0.5460772	0.4274128
3	0.7866058	1.1077202	1.6469943	2.55253	3.073202	2.5740563	1.6494469
4	1.9029113	2.0038493	2.7397043	4.07618	6.311605	7.3951916	3.6959218
5	2.829217	2.7461502	2.6627835	4.01116	6.0592741	9.149873	8.4006577
6	3.3509035	3.706878	3.4796092	3.45223	5.5625131	8.0129581	11.50544
7	4.0690518	3.1546262	3.9557887	4.62839	4.6095489	6.4746853	9.9676017
8	2.2606424	1.4608479	1.1368304	1.90028	2.2888053	1.1980976	2.9367396
9	1.308485	0.7880356	0.5031646	0.50778	0.8805074	0.5608471	0.3203664
10	4.3540219	1.8784219	0.8622854	0.5686	0.4514679	0.2817571	0.0276597
age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	
2	0.29297148	0.3113617	0.44077224	0.62719	0.6990605	0.67054	

3	1.35573942	1.1896153	1.25090089	1.81278	2.607143	2.8677565
4	4.13633446	3.1210204	2.73466789	2.86372	4.1078098	5.906775
5	6.61486904	5.8424487	4.35972944	3.83657	3.8903534	5.6689845
6	5.78952355	7.3459563	6.49219055	4.57657	4.2672091	4.1221711
7	1.39305893	3.0417713	4.76896834	5.54214	3.2639888	2.2103149
8	0.32508129	0.1933951	0.63917628	0.70348	1.1648834	0.6551461
9	0.08887983	0.0465984	0.03800225	0.09	0.114797	0.2094689
10	0.04320064	0.0165149	0.0106781	0.00576	0.0129082	0.0185134

Table 6.2.4.4.11. Black Sea turbot. Index at age, residuals (Ukr Trawl suvey East).

age/year	1989	1990	1991	1992	1993	1994	1998
2	0.957253	0.404502	1.02219	1.21719	0.866045	1.11297	-1.63293
3	1.50777	0.308258	0.387247	1.2899	0.762713	1.22905	-0.964287
4	1.36613	0.74868	1.30196	1.03181	0.378833	0.674201	-1.16358
5	1.30262	0.479593	1.52123	0.89666	0.975375	1.02251	-0.93774
6	1.27296	0.452639	1.21919	1.16981	0.648491	0.740311	-0.193996
7	0.449267	0.683726	0.536648	0.60054	0.784648	0.899958	-0.718108
8	0.195642	0.560773	0.242975	0.0296	0.811923	1.45357	0.0368826
9	0.421009	0.661153	0.649147	0.61203	1.12428	1.59145	-1.77338
10	-0.389539	0.0191623	-0.764525	-0.5031	1.20074	2.01922	-0.89048
age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	
2	-1.4687	-1.49517	-0.246589	0.07776	-0.181989	-0.50485	
3	-0.967628	-0.346431	-0.698965	0.45464	-1.26593	-1.55604	
4	-1.02163	-0.795359	-1.00016	0.68782	-0.658568	-1.45306	
5	-1.71266	-0.821587	-0.520642	0.19077	-0.832115	-1.48272	
6	-0.653378	-1.34641	-0.460003	-0.046	-1.06537	-1.61855	
7	0.574253	-0.697174	0.189175	-0.3535	-2.51951	-1.02658	
8	0.468132	-0.010249	0.449565	0.83734	-2.75324	-0.935914	
9	-1.11752	-0.078101	0.380768	-1.1239	-1.24841	-0.023662	
10	-1.28075	0.167588	1.35125	0.48314	-0.223439	-0.539082	

Table 6.2.4.4.12. Black Sea turbot. Predicted index at age (RO Trawl suvey).

age/year	2003	2004	2005	2006	2007	2008
4	106.735093	112.07407	161.555704	233.152	246.85719	225.61951
5	79.90992	70.525899	72.2108275	104.738	149.85677	141.74646
6	59.7171949	42.928245	39.1601638	38.3986	57.595244	85.838704
7	25.086002	26.235672	16.3394103	12.6087	15.808061	23.697747
8	0.47964741	0.6077389	0.91330709	0.51272	0.3163076	0.4664502
9	0.02616559	0.0713392	0.08258229	0.15041	0.0850046	0.0461393
age/year	**2009**	**2010**	**2011**	**2012**	**2013**	
4	171.196154	127.40487	115.782103	97.8925	69.025776	
5	123.727306	88.857148	65.1733081	61.0016	45.418522	

6	73.2047273	59.517477	41.9802807	28.4026	24.867457
7	37.0912095	31.052521	24.8262112	13.1446	8.5651359
8	0.97075496	1.481894	1.0822049	0.69783	0.1559313
9	0.08558031	0.2491077	0.3128035	0.15229	0.045319

Table 6.2.4.4.13. Black Sea turbot. Index at age, residuals (RO Trawl survey).

age/year	2003	2004	2005	2006	2007	2008
4	-1.02935	-1.47701	-0.916537	-1.2218	-0.019859	0.0282706
5	-0.56216	0.238211	0.238901	0.83934	-0.901956	-0.868809
6	0.286271	0.831059	-0.83757	-0.0814	-1.35936	-1.59326
7	0.808577	-0.802781	0.0687982	-0.2409	-0.285014	-0.937776
8	-1.16514	0.992545	0.947791	-1.1852	-1.03981	-1.15674
9	-0.368935	-0.753652	-0.809786	-1.0398	-0.820875	-0.586503
age/year	2009	2010	2011	2012	2013	
4	-0.584429	-0.017741	1.04138	0.71984	-0.027138	
5	-0.369279	0.277869	1.93994	2.23099	-0.199578	
6	-0.409127	-0.385875	0.866797	1.93372	0.156846	
7	-0.0663954	-0.301953	0.752128	2.51289	0.764951	
8	0.828731	0.636582	1.0265	1.01118	-0.826888	
9	1.83069	0.88914	1.17878	1.23089	-0.579622	

Table 6.2.4.4.14. Black Sea turbot. Predicted index at age (BG Trawl suvey).

age/year	2006	2007	2008	2009	2010	2011	2012
2	72.736986	58.14675	45.00799	37.8193	32.04913	26.88558	24.738234
3	112.802669	106.64227	82.33778	61.6942	53.83156	47.09279	34.29673
4	110.381219	116.86857	106.81517	81.0487	60.31676	54.81479	46.345305
5	66.97303	95.8237	90.63858	79.1156	56.81839	41.67411	39.006566
6	28.988233	43.48039	64.80158	55.2639	44.93109	31.69218	21.441965
7	9.518621	11.93386	17.88997	28.0013	23.44249	18.74187	9.923146

Table 6.2.4.4.15. Black Sea turbot. Index at age, residuals (BG Trawl survey).

age/year	2006	2007	2008	2009	2010	2011	2012
2	1.00511	0.682121	1.20068	-0.5753	-1.65324	0.318993	-0.828296
3	0.86033	0.809197	0.380894	0.84554	-2.01793	-0.213072	-0.573261
4	-0.0195916	1.42064	0.966356	0.718	-1.25407	-1.00766	-0.780429
5	-0.592513	0.931498	1.34527	0.8285	0.0129773	-1.12132	-1.3403
6	-0.258736	1.15996	1.5258	1.04036	-0.325388	-0.309286	-1.30327
7	0.432462	0.556648	0.396433	0.35432	-1.04732	0.539386	-1.58784

Table 6.2.4.4.16. Black Sea turbot. Fit parameters.

name	value	std.dev	
1	logFpar	-3.1013	5.64E-01
2	logFpar	0.61104	4.59E-01
3	logFpar	-1.044	9.29E-02
4	logFpar	-3.0682	1.01E+00
5	logFpar	-3.1539	8.11E-01
6	logFpar	-2.2891	1.80E-01
7	logFpar	-1.4467	1.34E-01
8	logFpar	-0.86175	1.33E-01
9	logFpar	-0.058422	2.13E-01
10	logFpar	0.26017	3.13E-01
11	logFpar	1.018	3.43E-01
12	logFpar	-0.64332	6.47E-01
13	logFpar	-7.4448	6.42E-01
14	logFpar	-5.7787	3.86E-01
15	logFpar	-4.6072	2.90E-01
16	logFpar	-3.8125	2.97E-01
17	logFpar	-3.0624	2.96E-01
18	logFpar	-2.3228	2.43E-01
19	logFpar	-2.543	4.82E-01
20	logFpar	-2.8204	4.42E-01
21	logFpar	-2.1875	3.82E-01
22	logFpar	-1.7918	2.89E-01
23	logFpar	-1.4912	3.16E-01
24	logFpar	-1.3251	1.26E-01
25	logFpar	-1.5784	2.54E-01
26	logFpar	-0.78773	2.22E-01
27	logFpar	-0.19946	2.04E-01
28	logFpar	0.14339	2.34E-01
29	logFpar	0.64415	2.01E-01
30	logFpar	1.028	2.09E-01
31	logFpar	1.3592	2.45E-01
32	logSdLogFsta	0.59057	2.08E-01
33	logSdLogFsta	-0.98351	1.46E-01
34	logSdLogN	-1.3145	1.22E-01
35	logSdLogN	-3	1.52E-06
36	logSdLogObs	-0.11597	4.70E-01
37	logSdLogObs	0.21746	1.17E-01
38	logSdLogObs	-0.065742	1.20E-01
39	logSdLogObs	-0.60166	1.59E-01
40	logSdLogObs	-0.82746	1.63E-01
41	logSdLogObs	-1.7536	4.75E-01
42	logSdLogObs	-0.61517	1.10E-01
43	logSdLogObs	0.25135	1.06E-01
44	logSdLogObs	-0.94603	1.95E-01
45	logSdLogObs	-0.58167	1.81E-01

name	value	std.dev	
46	logSdLogObs	1.2005	2.15E-01
47	logSdLogObs	0.95824	2.19E-01
48	logSdLogObs	-0.44468	2.00E-01
49	logSdLogObs	-0.77205	1.53E-01
50	logSdLogObs	-0.30821	2.14E-01
51	logSdLogObs	0.0949	2.02E-01
52	logSdLogObs	0.048515	2.22E-01
53	logSdLogObs	0.70003	1.99E-01
54	logSdLogObs	0.83276	1.98E-01
55	logSdLogObs	0.31507	2.00E-01
56	logSdLogObs	0.025718	2.02E-01
57	logSdLogObs	0.051483	1.20E-01
58	logSdLogObs	0.54701	2.01E-01
59	logSdLogObs	0.67037	2.05E-01
60	logSdLogObs	0.13323	2.26E-01
61	logSdLogObs	0.10596	2.78E-01
62	logSdLogObs	-0.034317	2.78E-01
63	logSdLogObs	-0.31894	2.85E-01
64	logSdLogObs	-0.20849	2.80E-01
65	logSdLogObs	-0.51607	2.84E-01
66	logSdLogObs	-1.3482	4.33E-01
67	logSdLogObs	1.0675	1.37E-01
68	logSdLogObs	0.24929	1.40E-01
69	logSdLogObs	0.12046	1.39E-01
70	logSdLogObs	0.035128	1.40E-01
71	logSdLogObs	0.17864	1.39E-01
72	logSdLogObs	0.0003296	9.12E-02
73	logSdLogObs	0.61763	1.44E-01

Multiple SAM model runs were done using the officially reported landings and the reconstructed landings including IUU catches to test the effect on SSB, recruitment and fishing mortality. When official landings were used, SSB was estimated to be around 60% lower in the last year compared to the run which includes also IUU landings but not significant changes in F and recruitment were observed. and Thus the inclusion or exclusion of IUU catches does not affect the perception of the stock status. Thus, STECF EWG 14 14 decided to use the landings including IUU in the final assessment.

The SAM estimated recruitment has four peaks in 1965 – 1968, 1974 – 1978, 1991 – 1994 and 2004 – 2007 and three lows in 1982-85, 1996 – 1997 and after 2009. Correspondingly, SSB attained higher values up to 12 689 t in 1977 – 1982 and very low values after 2009. For the period after 2002, STECF EWG 14 14 is aware that misreporting of actual catches might be larger than assumed in the assessment (around 4.7 the official catches of Bulgaria, Romania and Ukraine). Fishing mortality F_{4-8} has a peaks of F~1.24 in 2000-2001 and F~1.33 during the recent years (2012 – 2013) (Fig. 6.2.4.4.1).

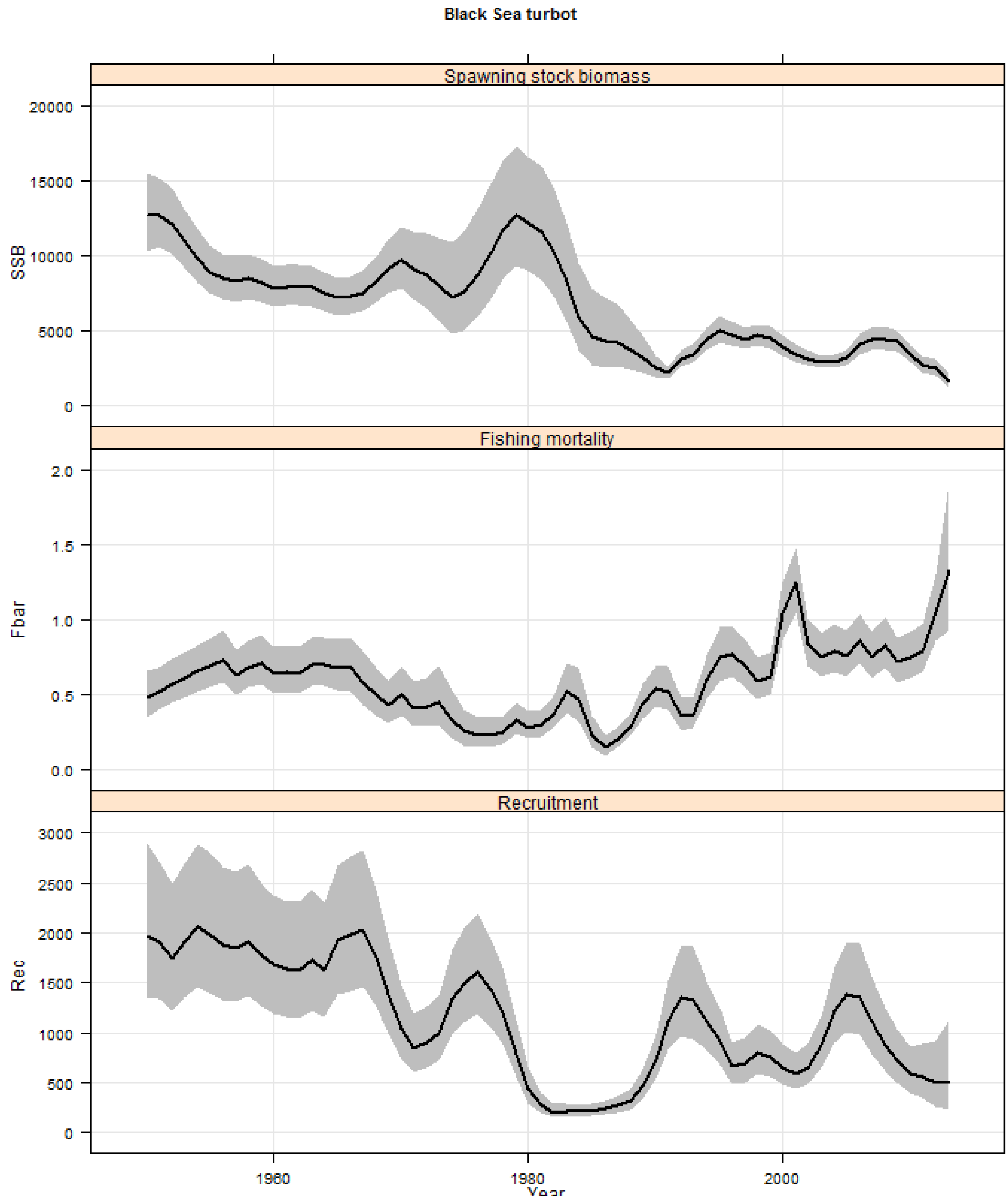


Figure 6.2.4.4.1. Time-series of population estimates of Black Sea turbot: SSB, F (ages 4–8) and recruitment with estimate of uncertainty.

6.2.5 Short term prediction of stock biomass and catch

6.2.5.1 Justification

Short term prediction of stock size and catch was conducted based on SAM results.

6.2.5.2 Input parameters

The input parameters are presented on the Table 6.2.5.2.1. and Fig. 6.2.5.2.1.

Table 6.2.5.2.1. Black Sea turbot. Input to short term prediction.

Catch Numbers							
age/year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2	117.382	128.96	83.862	9.311	294.674	58.215	135.85
3	220.447	139.24	224.049	29.855	92.415	94.85	57.522
4	418.457	312.07	251.296	103.77	83.081	156.768	207.85
5	201.385	197.27	162.742	183.66	107.532	131.293	212.49
6	103.231	132.29	93.987	153.73	46.091	46.144	85.401
7	37.013	69.431	117.221	86.314	56.057	71.553	37.768
8	4.862	24.002	19.222	40.255	63.96	43.978	18.225
9	4.737	3.987	2.761	13.489	28.782	21.683	10.578
10	0.508	1.524	0.029	3.321	8.611	5.676	1.111
Catch Weights							
age/year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2	0.794	0.571	0.66	0.683	0.604	0.594	0.454
3	1.4	1.356	1.155	1.188	1.129	1.39	1.227
4	1.891	1.791	1.749	1.726	1.658	1.956	1.592
5	2.441	2.42	2.423	2.511	2.363	2.64	2.257
6	3.119	3.001	3.415	2.622	3.192	3.364	3.087
7	4.706	4.015	4.197	3.846	3.708	4.272	3.93
8	6.06	4.694	5.192	5.177	4.962	5.645	4.662
9	7.5	5.697	6.323	5.999	5.627	6.552	5.946
10	9	6.643	7.109	7.575	7	6.894	7
Fishing mortality							
age/year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2	0.114876	0.1631	0.11067	0.0383	0.30913	0.21104	0.2988
3	0.15485	0.1681	0.17844	0.1651	0.17444	0.18424	0.1868
4	0.315941	0.3591	0.37677	0.3668	0.3331	0.38056	0.4318
5	0.390452	0.5074	0.56532	0.6632	0.69885	0.69977	0.8891
6	0.554294	0.4806	0.53842	0.6316	0.56302	0.68453	0.8333
7	0.897116	0.9584	0.95852	0.9073	0.85006	1.5022	1.4425
8	1.575212	1.8401	1.12305	1.1777	1.51041	1.99244	3.0538
9	1.575212	1.8401	1.12305	1.1777	1.51041	1.99244	3.0538
10	1.575212	1.8401	1.12305	1.1777	1.51041	1.99244	3.0538
Natural mortality							
age/year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2	0.146	0.146	0.146	0.146	0.146	0.146	0.146
3	0.139	0.139	0.139	0.139	0.139	0.139	0.139
4	0.136	0.136	0.136	0.136	0.136	0.136	0.136
5	0.134	0.134	0.134	0.134	0.134	0.134	0.134
6	0.133	0.133	0.133	0.133	0.133	0.133	0.133
7	0.132	0.132	0.132	0.132	0.132	0.132	0.132

8	0.131	0.131	0.131	0.131	0.131	0.131	0.131
9	0.13	0.13	0.13	0.13	0.13	0.13	0.13
10	0.13	0.13	0.13	0.13	0.13	0.13	0.13

Maturity

age/year	2007	2008	2009	2010	2011	2012	2013
2	0	0	0	0	0	0	0
3	0.431667	0.4317	0.43167	0.4317	0.43167	0.43167	0.4317
4	0.678333	0.6783	0.67833	0.6783	0.67833	0.67833	0.6783
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1

Stock Numbers

age/year	2007	2008	2009	2010	2011	2012	2013
2	1111.872	881.65	721.621	589.81	566.513	496.31	504.47
3	1100.918	855.68	644.452	558.58	490.978	359.315	346.61
4	879.0133	820.9	628.415	465.35	415.84	360.035	260.45
5	553.2998	554.85	498.548	376	280.76	262.907	215.19
6	230.6958	331.39	290.906	247.79	168.882	121.413	114.51
7	75.11348	116.12	181.744	148.31	115.227	84.5295	53.458
8	15.96342	26.872	39.0757	61.301	52.8734	43.3844	16.483
9	4.67206	2.8953	3.75204	11.223	16.6432	10.3119	5.2174
10	1.651114	1.1485	0.56065	1.2357	3.37502	3.88297	1.6979

Stock Weights

age/year	2007	2008	2009	2010	2011	2012	2013
2	0.794	0.571	0.66	0.683	0.604	0.594	0.454
3	1.4	1.356	1.155	1.188	1.129	1.39	1.227
4	1.891	1.791	1.749	1.726	1.658	1.956	1.592
5	2.441	2.42	2.423	2.511	2.363	2.64	2.257
6	3.119	3.001	3.415	2.622	3.192	3.364	3.087
7	4.706	4.015	4.197	3.846	3.708	4.272	3.93
8	6.06	4.694	5.192	5.177	4.962	5.645	4.662
9	7.5	5.697	6.323	5.999	5.627	6.552	5.946
10	9	6.643	7.109	7.575	7	6.894	7

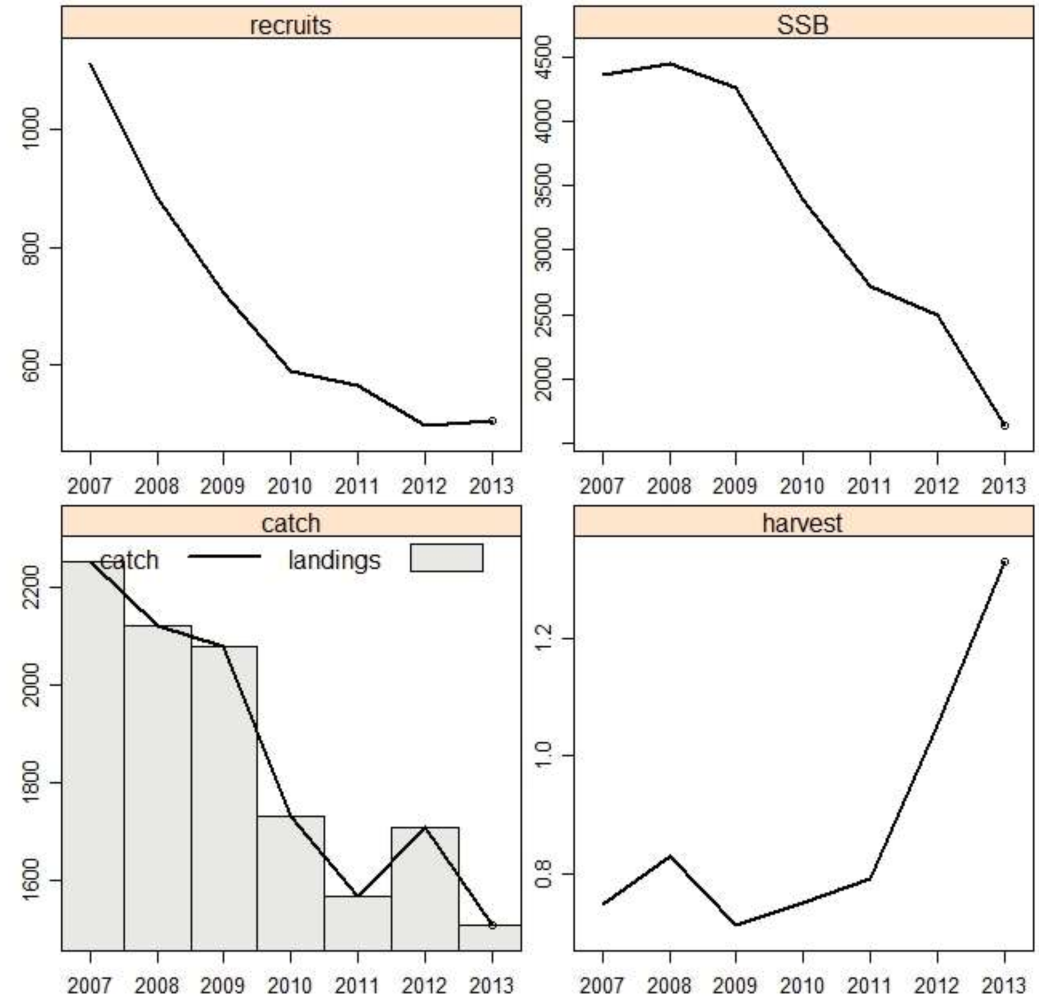


Figure 6.2.5.2.1. Input data, used for short-term predictions.

Short term forecast in different F scenarios computed for Black Sea turbot. Basis: F (2014) = average F (2011-2013) = 1.06; R (2014) = GM (2011–2013) = XXX (thousands); SSB (2015) = 1310 t; Catch (2014) = 724 t.

6.2.5.3 Results

Table 6.2.5.3.1. Turbot in Black Sea. Short term prediction.

Fscenario	Fmult	Catch_2014	Catch_2015	Catch_2016	Landings_2014	Landings_2015	Landings_2016	SSB_2014	SSB_2015	SSB_2016	Change SSB_2014_2016	ChangeCatch_2015_2013
0.26	**0.25**	**724.50**	**213.38**	**306.23**	**724.50**	**213.38**	**306.23**	**1310.12**	**1211.86**	**1686.49**	**28.73**	**-85.87**
0.00	**0.00**	**724.50**	**0.00**	**0.00**	**724.50**	**0.00**	**0.00**	**1310.12**	**1211.86**	**1933.56**	**47.59**	**-100.00**
0.11	0.10	724.50	92.07	147.27	724.50	92.07	147.27	1310.12	1211.86	1826.75	39.43	-93.90
0.21	0.20	724.50	176.79	262.15	724.50	176.79	262.15	1310.12	1211.86	1728.73	31.95	-88.30
0.32	0.30	724.50	254.99	352.57	724.50	254.99	352.57	1310.12	1211.86	1638.52	25.07	-83.12
0.42	0.40	724.50	327.39	424.28	724.50	327.39	424.28	1310.12	1211.86	1555.23	18.71	-78.32
0.53	0.50	724.50	394.61	481.46	724.50	394.61	481.46	1310.12	1211.86	1478.15	12.83	-73.87
0.63	0.60	724.50	457.19	527.25	724.50	457.19	527.25	1310.12	1211.86	1406.63	7.37	-69.73

0.74	0.70	724.50	515.58	563.98	724.50	515.58	563.98	1310.12	1211.86	1340.10	2.29	-65.87
0.85	0.80	724.50	570.19	593.42	724.50	570.19	593.42	1310.12	1211.86	1278.10	-2.44	-62.25
0.95	0.90	724.50	621.37	616.96	724.50	621.37	616.96	1310.12	1211.86	1220.20	-6.86	-58.86
1.06	1.00	724.50	669.43	635.66	724.50	669.43	635.66	1310.12	1211.86	1166.03	-11.00	-55.68
1.16	1.10	724.50	714.64	650.37	724.50	714.64	650.37	1310.12	1211.86	1115.25	-14.87	-52.69
1.27	1.20	724.50	757.24	661.78	724.50	757.24	661.78	1310.12	1211.86	1067.58	-18.51	-49.87
1.38	1.30	724.50	797.44	670.42	724.50	797.44	670.42	1310.12	1211.86	1022.76	-21.93	-47.20
1.48	1.40	724.50	835.44	676.76	724.50	835.44	676.76	1310.12	1211.86	980.56	-25.15	-44.69
1.59	1.50	724.50	871.40	681.15	724.50	871.40	681.15	1310.12	1211.86	940.78	-28.19	-42.31
1.69	1.60	724.50	905.49	683.90	724.50	905.49	683.90	1310.12	1211.86	903.22	-31.06	-40.05
1.80	1.70	724.50	937.83	685.28	724.50	937.83	685.28	1310.12	1211.86	867.72	-33.77	-37.91
1.90	1.80	724.50	968.55	685.48	724.50	968.55	685.48	1310.12	1211.86	834.14	-36.33	-35.88
2.01	1.90	724.50	997.76	684.70	724.50	997.76	684.70	1310.12	1211.86	802.32	-38.76	-33.94
2.12	2.00	724.50	1025.57	683.09	724.50	1025.57	683.09	1310.12	1211.86	772.16	-41.06	-32.10

Fishing at the F_{stq} generates a decrease of the catch of 56 % from 2013 to 2015 and a decrease of the spawning stock biomass of 11% from 2015 to 2016.

Fishing at F_{MSY} (0.26) generates a decrease of the catch of about 86 % from 2013 to 2015 and an increase of the spawning stock biomass of 29 % in the same period.

Catches of turbot in 2015 consistent with FMSY would not exceed 213 tonnes.

In case of closed turbot fishery (zero catches) in 2015, the SSB increases of about 48 % in 2016.

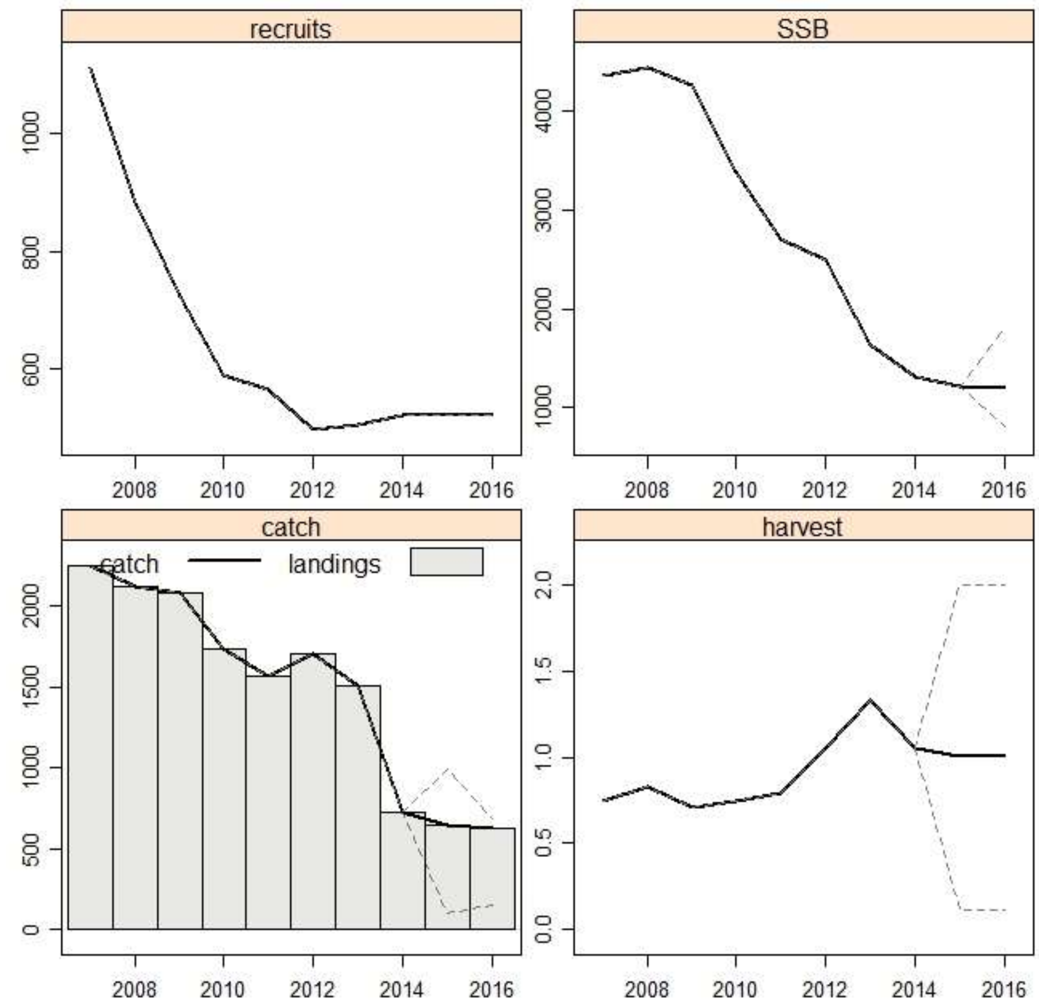


Figure 6.2.5.3.1. Black Sea turbot. Short term predictions.

6.2.6 Medium term prediction of stock biomass and catch

The STECF EWG 14 14 did not undertake medium term projections

6.2.7 Long term predictions

The STECF EWG 14 14 did not undertake long term projections.

6.2.8 Scientific advice

6.2.8.1 Short term considerations

State of the spawning stock size: The assessment indicates that the spawning stock biomass continues to be at very low level (around 1634 t) and it is estimated to be around half of B_{lim} (3535 t). F in 2013 (1.33) is more than five times higher than F_{msy} (0.26).

State of recruitment: Recruitment peaked during the period 2004 - 2007 and decreased thereafter.

State of exploitation: The STECF EWG 14 14 apply F_{msy} to be equal to 0.26 (i.e. F which maximises average catch in the long run) as limit reference point consistent with high long term yields . F in 2013 is at the high level around 1.33, more than 5 times F_{msy}. The EWG classifies the stock of turbot in the Black Sea as being exploited unsustainably and at the risk of collapse. The EWG notes that fishing mortality remains at high level with no signal of reduction. EWG consider that on the basis of precautionary considerations that there should be no directed fisheries and bycatch should be minimised.

6.3 WHITING IN GSA 29

6.3.1 Biological features

6.3.1.1 Stock identification

In the Black Sea, whiting is one of the most abundant species among the demersal fishes. It does not undertake distant migrations, spawning occurs mainly in the cold season within the whole habitat area (Fig. 6.3.1.1). The whiting produces pelagic juveniles, which inhabit the upper 10-meter water layer for about a year. The adult whiting is cold-living, preferring temperatures 6-10 C. Fishes below age 6 dominate the whiting population, the older year classes are found in catches rarely. It is found all along the shelf where dense commercial concentrations are formed by 1-3 year old fishes in the water down to 150 m depth, most often between 60-120 m (Shlyakhov, 1983; Ozdamar et al, 1996). Such concentrations on the shelf of Bulgaria, Georgia, Romania, the Russian Federation and Ukraine do not occur every year; they appear at periods of 4-6 years - in the years of appearance of highly productive year classes. In these countries, whiting is rarely the target species in fisheries and is usually yielded as by-catch during trawl fishing for other fish species or during non-selective fishing with fixed nets in the coastal areas (Shlyakhov and Daskalov, 2008). In the vicinity of the southern coast of the Black Sea whiting concentrations are more stable.

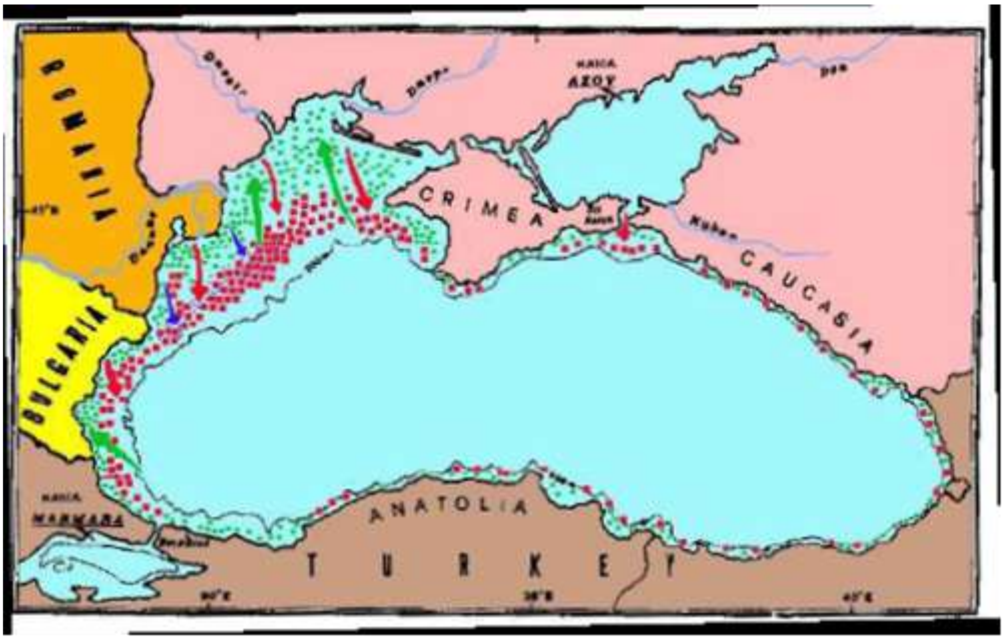


Fig. 6.3.1.1. Map of distribution of Whiting in the Black Sea

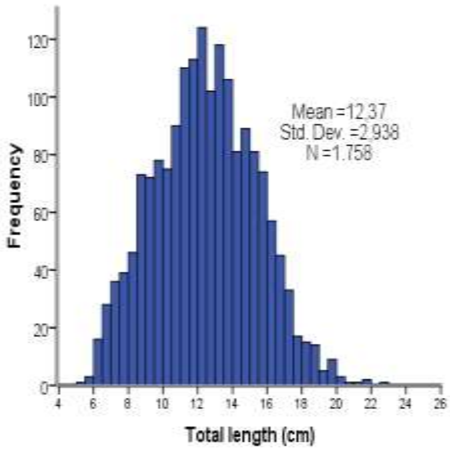
The problem of units for whiting stocks in the Black Sea has not been settled yet. Fisheries experts from the Black Sea Commission specify the stock as shared although this fish does not undertakelong migrations; its whole stock (or two different stocks – Eastern and Western) is exploited by each Black Sea country in their waters. In this case, the part of the stock (or local stocks) that is distributed outside the Turkish waters, is lightly exploited and mainly as a bycatch in other fisheries.

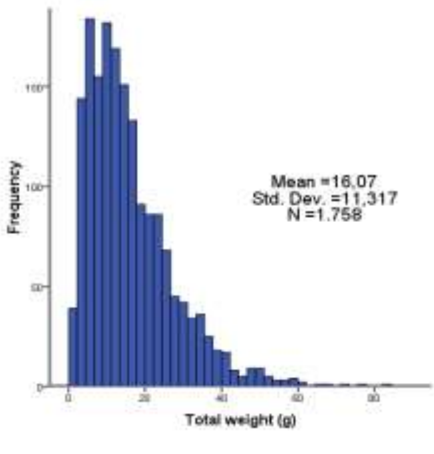
6.3.1.2 Stock structure assumed in the assessment

The present assessment is based on the analysis of the best available information, obtained from combined data of all Black Sea countries except Georgia and assuming the stock forms a single unit in the entire Black Sea.

6.3.1.3 Growth

The determination of the biological parameters represents an important objective for the establishment of the demographic structure, the growth parameters, as well as other parameters required for the study of recruitment, mortality, and effective biomass, divided into age classes. In the Black Sea former USSR waters in areas with a narrow shelf, whiting population was characterised by a predominance of larger-sized fishes than in the grounds with wide shelf (Shlyakhov, 1983). During 1996 – 2005 in the grounds of intensive Turkish trawl fisheries one could observe a tendency for reduction of mean length of fishes which became equal or even less than in Ukrainian waters. It is not quite typical and in our opinion it is the evidence of excessive fishing effort. Turkish scientists came to the same conclusion. Thus, according to the results of Genç *et al.* (2002), applying methods of LCA and Thompson and Bell, modern whiting fisheries in the waters of Turkey is conducted with excessive F due to trawls with mesh size less than 22 mm. İşmen (1995, 2006) estimated existing fishing intensity to F=1.24 and considered possible to achieve optimal exploitation of whiting by means of decrease in fishing intensity or an enforcement of a minimum allowable total length. Thus, whiting stock in the waters of Turkey may be characterized as excessively exploited. The Turkish data for 2013 were derived from monthly sampled catches as in previous years. All samplings were provided from commercial bottom trawls operating in Samsun Shelf Area and west Black Sea Turkish coasts. The length and weight range between 5.4 cm and 22.7 cm and 1.17g and 82.99g, respectively. The average length was 12.37 (±0.07) cm and the average weight was 16.07 (±0.27) cm. Age groups range between 0 and 8 year. The most dominant age group was age 2 (48.42%) followed by age 3 (26,53%) and age 1 (20,59%). The constant and slope was calculated as 0.007 and 3.02 (N=1758, R=0.99) for the l-w relationship. The growth parameters were estimated from 2013 sampling as L_∞=24.307 cm, K= 0.323 cm/y and t_o=-1.468 y that reveals phi Prime value as 2.281. The mortality was estimated as 0,506 according to Pauly's equation (Fig. 6.3.1.3.1).





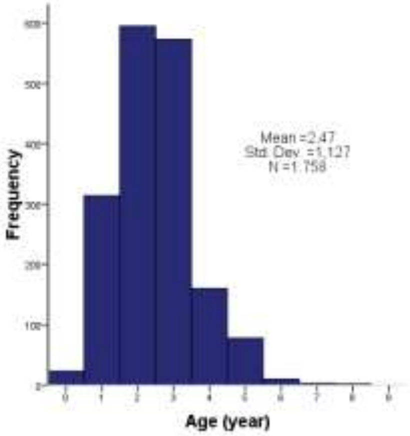


Fig. 6.3.1.3.1 The length, weight and age frequency (n=1758) distributions of Whiting from Turkish coasts for 2013.

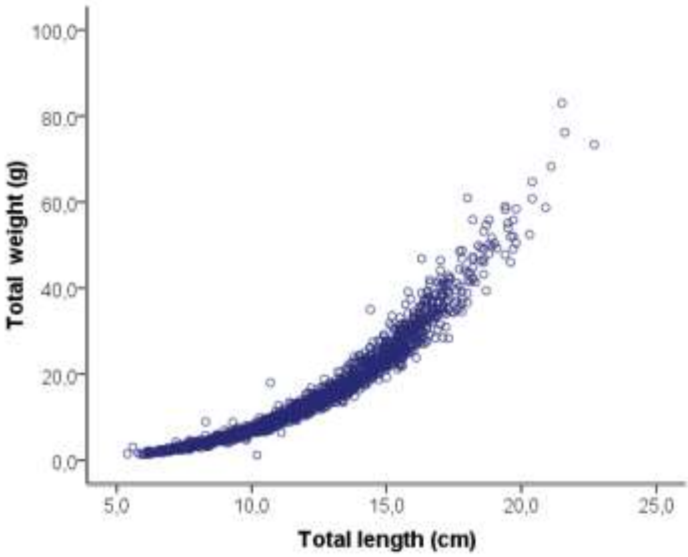


Fig. 6.3.1.3.2 Length-weight relationship of the Whiting population of Turkish coast (n=1758) for 2013.

The Romanian data for 2013 were derived from monthly sampled catches as in previous years. All samplings were provided from commercial bottom trawls operating in Romanian waters. The length and weight range between 5.0 cm and 16.5 cm and 1.15 g and 46.12 g, respectively. The average length was 10.38 cm and the average weight was 8.58 cm. Age groups range between 0 and 4 year. The most dominant age group was age 2 (48.42%) followed by age 3 (26,53%) and age 1 (20,59%). The intercept and slope was calculated as 0.007 and 3.02 (N=1758, R=0.99) for the l-w relationship. The growth parameters were estimated from 2013 sampling as L_∞= 18.201 cm, K= 0.289, t_0=-1.0848 and b = 2.772582, q = - 1.89702, a = 0.012676. The mortality was estimated as 0,574 according to Beverton-Holt equation (Fig. 6.3.1.3.3) (Radu and Maximov, 2013).

The analysis of age components during the entire 2013 fishing season emphasized the presence of individuals aged in Romanian waters between 0+ to 4-4+ years, for Turkish 0+ to 8-8+ year classes, in Bulgarian and Ukrainian (2012) waters between 0+ to 5-5+ years (Figure 6.3.1.3.4). Otolits age reading of whiting carried out shows large discrepancies, judging by the differences in average weight-at-age in determining the age of fish older than two years (Figure 6.3.1.3.5). This could be an indication of the existence of various local whiting stocks or non intercalibrated age readings.

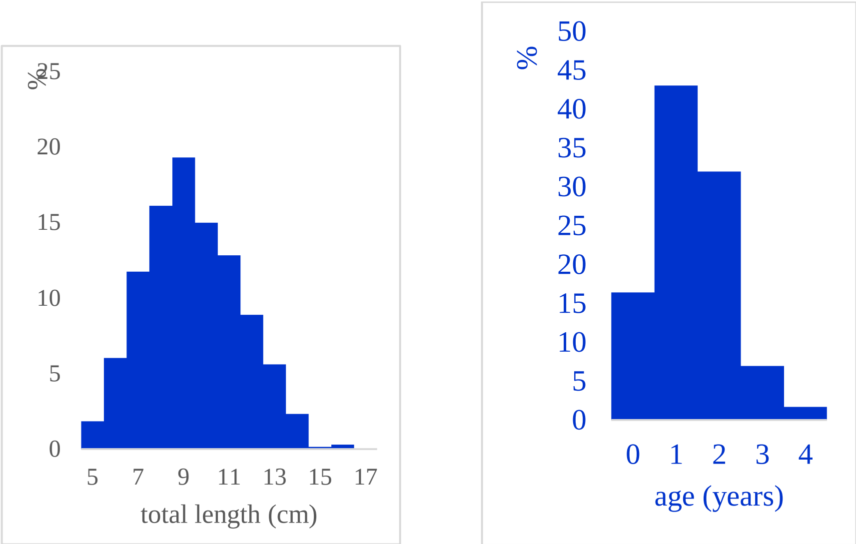


Fig. 6.3.1.3.3. The length and age frequency (n=1499) distributions of whiting from Romanian coasts for 2013.

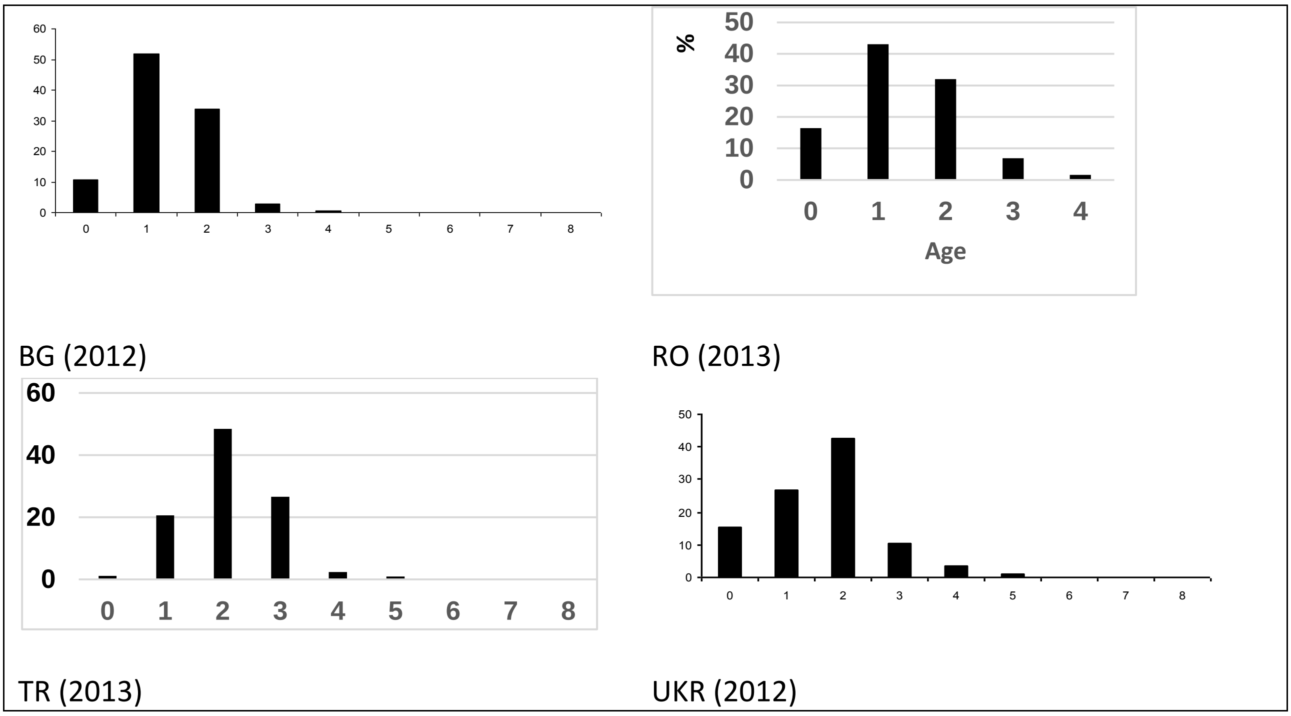


Fig. 6.3.1.3.4. The age composition of landings whiting in Romania and Turkey and Ukraine and Bulgaria

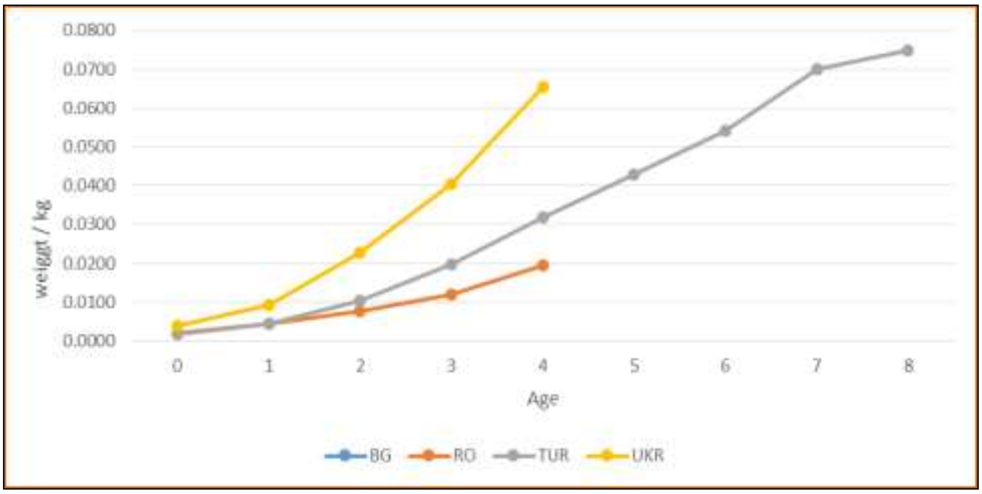


Fig. 6.3.1.3.5 The average weight of whiting by age in 2013

6.3.1.4 Maturity

In the population of the Black Sea whiting, maturation of males takes place on the first and second year of life, and that of females - after age 1 (Svetovidov, 1964 Shlyakhov, 1983). For the purposes of stock assessment female maturitiy ogives are used. In previous assessments EWG took into account the data of Romania and Ukraine for ages 0 + - 0%, 1 - 75%, 2 and older - 100% (Fig. 6.3.1.4.1). According to the data of Romanian and Turkish scientists, the whiting rate of maturation of females in 2013 was slower than in previous years.

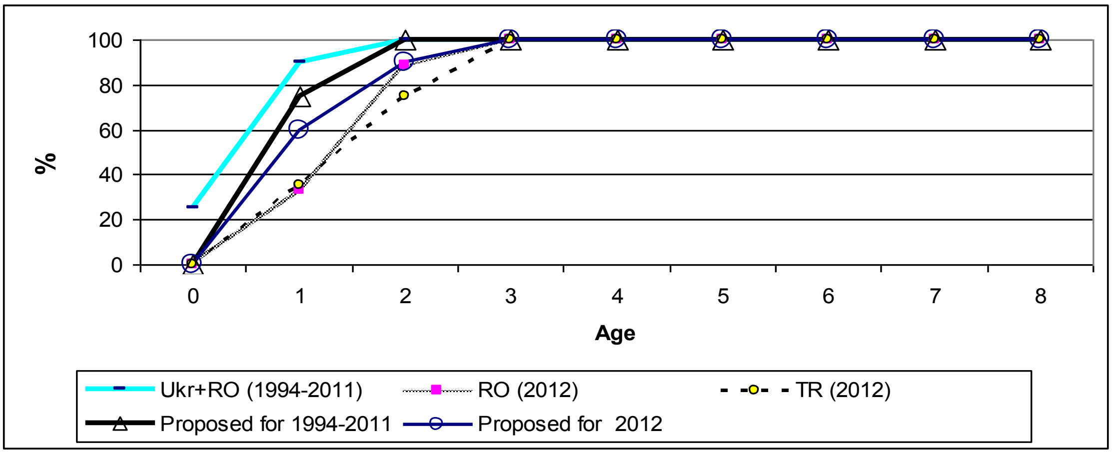


Fig. 6.3.1.4.1 Maturity proportion of the Black Sea Whiting in 1994-2013

6.3.2 Fisheries

6.3.2.1 General Description

In Black Sea, Turkey is the only country where the whiting is target for the fisheries. Thus, about 99% of the catch of blue whiting from the 1990s is now landed by Turkey, although the area of its continental shelf in the Black Sea does not exceed 10%.

There are four fishing methods for whiting in Turkish Black Sea coasts. The first is trawl nets and catches 82.1% of total catch with a mean length of 16.1 cm. Gill nets were also used in the whiting fishery and obtained 13.6% of total catch and a mean length of 18.2 cm. The remaining 3.7% of the lanidngs is made by purse seines and 0.6% by lines with mean catch lengths of 16.0 cm and 19.6 cm, respectively (Zengin et al., 1998). As it is seen above, the bottom trawl fishery is the major method in whiting fishery.

6.3.2.2 Management regulations applicable in 2012 and 2013

The general management criteria announced by General Directorate of Fisheries for 2012 - 2014 are described below. The summary of whiting regulation is given Table 6.3.2.2.1.

Table 6.3.2.2.1. The current recommended of parameters for fisheries regulation on the whiting stocks along the Turkish Black Sea

Regional area	Official mesh size for bottom trawl	Legal landing size (TL)	First maturation size (TL50%)	Scientifically recommended minimum catch length (cm)	Scientifically recommended mesh size for bottom trawl
Southern Black sea coasts (Turkey)	40 mm	13.0 cm	14.5 cm	15.0 cm	44 mm

(1) Area closures: The whiting fishery with bottom trawls is prohibited along waters a) between Sinop city, İnceburun (42° 05.959' N-34° 56.695' E) and Samsun city, Yakakent, Çayağzı Cape (41° 41.040' N-35° 25.193' E), b) between Ordu city, Unye; Taskana Cape (41° 08.725' N-37° 17.531' E) and Georgia border, c) between Ereğli Baba Cape (41° 17.342' N-31° 23.937' E) and Bartın city, Amasra, Tekke Cape (41° 43.485' N-32° 19.258' E) in 2 miles from land. Furthermore, in open areas it is prohibited to make any fishery within 3 miles from land (Fig. 6.3.2.2.1).

(2) Time closures: In open areas, the whiting fishery is prohibited between 15 April-15 September.

(3) Mesh size limitations: The mesh size should not be lower than 40 mm.

(4) Minimum legal catch size: For all kind of fisheries minimum legal size (total length) is 13 cm.

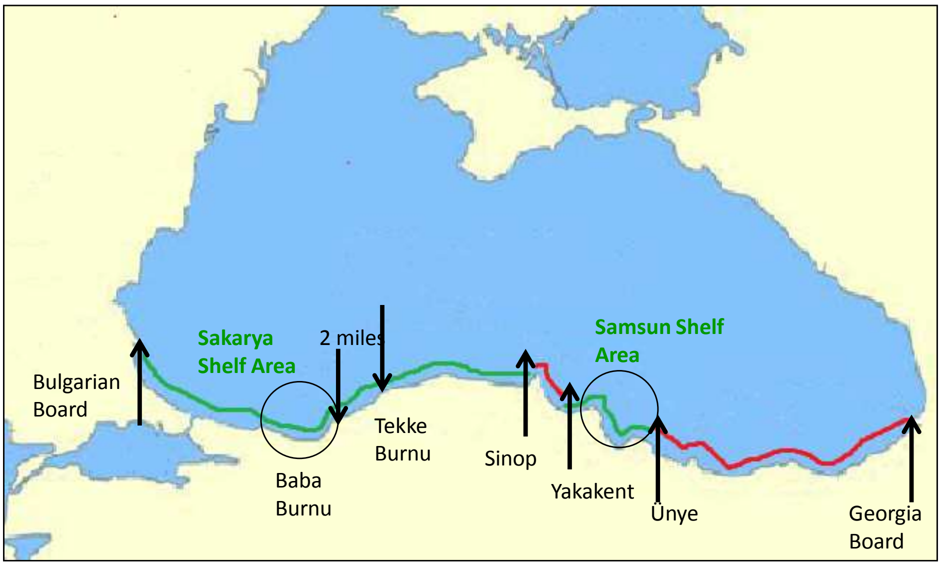


Fig. 6.3.2.2.1 Area closures and limitations for distance from land for bottom trawling along Turkish coasts (Green lines: open areas, red lines: area closures)

The whiting fishing fleet grew significantly after 1990 also targeting other demersal fishes. The number of bottom trawl vessels is not constant as they can also operate as mid-trawl vessels by changing gear equipment depending on actual fish movements and follow the schools of pelagic species. Depending on official records there are over a hundred of bottom trawls operating in Samsun Shelf Area at present.

There is no limitation in mesh size for gill net fishery of whiting but the fishermen generally use the gears with 32 mm mesh size. However, by the decrease in mean individual size in recent years, they also started to use nets with 28 mm mesh size. In relation with the decrease in landings of whiting in the last three decades, a clear negative gradient was determined in mesh size of gill nets with ten year intervals (Zengin, 2012)(Fig. 6.3.2.2.2).

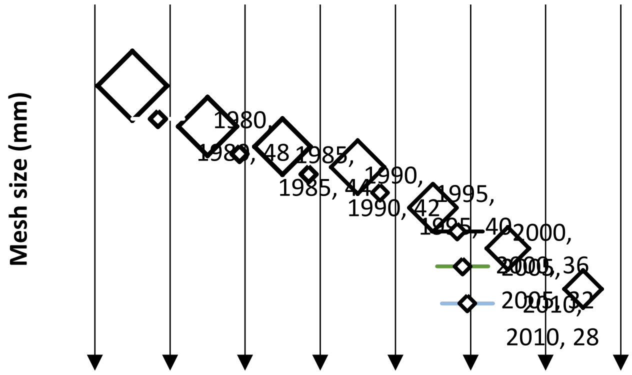


Fig. 6.3.2.2.2. The change in mesh size of gill nets used in Whiting fishery in the last three decades (Zengin, 2013).

Until 2000, whiting nets were produced with monofilament fishing strings (transparent). By the ruling of General Directorate of Fisheries in 2010, the use of monofilament strings was prohibited. A period of one year was allowed for the alteration of nets to multifilament (synthetic) nets. This period ended by September, 2011.

“Regulations of the Commercial Fisheries in the Black Sea Basin” currently in force in Ukraine have determined the following requirements: minimum commercial size of whiting – 12 cm (SL); the allowable by-catch of its juveniles – not more than 20% of total biomass of catch during non-target trawl fisheries and not more of 30% in number during the target fisheries with trawls (with mesh size not less than 12 mm).

Up to 2012 the annual regulation of whiting fisheries included determination of the limits for whiting harvesting on the basis of its stock value and TAC. It should be noted, that even taking into account the by-catch in sprat fisheries, the total yield of whiting in the Ukrainian waters does not exceed 30% of TAC. According the Law of Ukraine № 3677-VI (adopted in June 2011) the value of catch of any marine biological resource is not limited if it does not reach an exploitation level that threatens the state of stocks (due to the nature of their spatial distribution, or because of the limited technical capabilities of fishing). TACs for whiting in Ukrainian waters far exceeds the technical capacity of the national fishing fleet. For example, in 2012, the TAC was equal to 8900 tons and the projected actual catch was less than 40 tons. Therefore, since 2013 for whiting no limit is set.

6.3.2.3 Catches

6.3.2.3.1 Landings

The following table lists the whiting landings over the period 1980-2012 (Table 6.3.2.3.1). Remarkable decrease occurred in Turkish landings of whiting caught by bottom trawls in recent two decades and the decrease seems on-going. The main reasons may be the illegal fishery by infringements of time and area, mesh size applications and increase in fishing effort. The mean length of landed catch for long years is another evidence of the exhaustion in whiting population. The mean total length for whiting decreased from 19.7 cm to 8.9 cm and the landings from 16.3 to 8.1 thousand tons from 1990 to 2012.

Table 6.3.2.3.1.1 Whiting landings (tons) by countries (FAO Fisheries Statistics, GFCM Capture Production 1980 – 2008, 2009 – 2013 from National Fisheries Statistics of countries)

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Former USSR
1970	-	.	115	.	4312	.	.
1971	-	.	442	.	5855	.	.
1972	-	.	416	.	5284	.	.
1973	-	.	329	.	2476	.	.
1974	-	.	1305	.	2844	.	.
1975	454	.	346	.	3913	.	.
1976	347	.	541	.	4213	.	.
1977	218	.	1495	.	5726	.	.
1978	407	.	1345	.	21265	.	531
1979	71	.	1205	.	20778	.	11377
1980	30,0	.	618,0	.	6838,0	1102,0	2690,0
1981	1,0	.	894,0	.	4669,0	2083,0	2238,0
1982	4,0	.	800,0	.	4264,0	825,0	1513,0
1983	0,0	.	1080,0	.	11696,0	817,0	2381,0
1984	0,0	.	1192,0	.	11595,0	2252,0	4738,0
1985	0,0	.	3138,0	.	16036,0	1101,0	2655,0
1986	0,0	.	1949,0	.	17738,0	1867,0	2652,0
1987	0,0	.	615,0	.	27103,0	579,0	2764,0
1988	0,0	5,0	1009,0	736,0	28263,0	1482,0	2223,0
1989	0,0	5,0	2739,0	7,0	19283,0	584,0	-
1990	0,0	0,0	2653,0	235,0	16259,0	87,0	-
1991	0,0	0,0	59,0	210,0	18956,0	24,0	-
1992	0,0	70,0	1357,0	37,0	17923,0	0,0	-
1993	0,0	172,0	599,0	16,0	17844,0	4,0	-
1994	0,0	187,0	432,0	125,0	15084,0	64,0	-
1995	0,0	146,0	327,0	91,0	17562,0	17,0	-
1996	0,0	223,0	389,0	11,0	20326,0	3,0	-
1997	0,0	58,0	441,0	10,0	12725,0	29,0	-
1998	0,0	53,0	640,0	119,0	11863,0	55,0	-
1999	0,0	41,0	272,4	184,0	12459,0	18,0	-
2000	9,0	36,5	275,0	341,0	15343,0	20,0	-
2001	8,0	32,0	306,0	642,0	7781,0	18,0	-
2002	16,0	37,0	85,0	656,0	7775,0	9,0	-
2003	13,0	45,0	113,4	93,0	7062,0	21,0	-
2004	2,0	29,0	117,6	55,0	7243,0	43,0	-
2005	3,0	30,0	93,3	78,0	6637,0	30,0	-
2006	2,0	37,0	96,7	60,0	7797,0	15,0	-
2007	16,1	41,0	17,1	22,0	11232,0	64,0	-
2008	0,4	15,0	55,2	96,0	10986,0	9,0	-
2009	2,3	15,0	39,5	52,0	8979,0	17,0	-
2010	14,7	15,0	23,6	23,0	11894,0	17,0	-
2011	1,0	42,0	0,1	20,9	8122,0	36,0	-
2012	1,4	42,0	0,4	2,8	6251,4	34,0	-
2013	5,3	-	1,1	15,0	8240,0	19,8	-

Landings/catches of Whiting after removal of age class 0 and 1 from the data are summarized in Figure 6.3.2.3.1.1

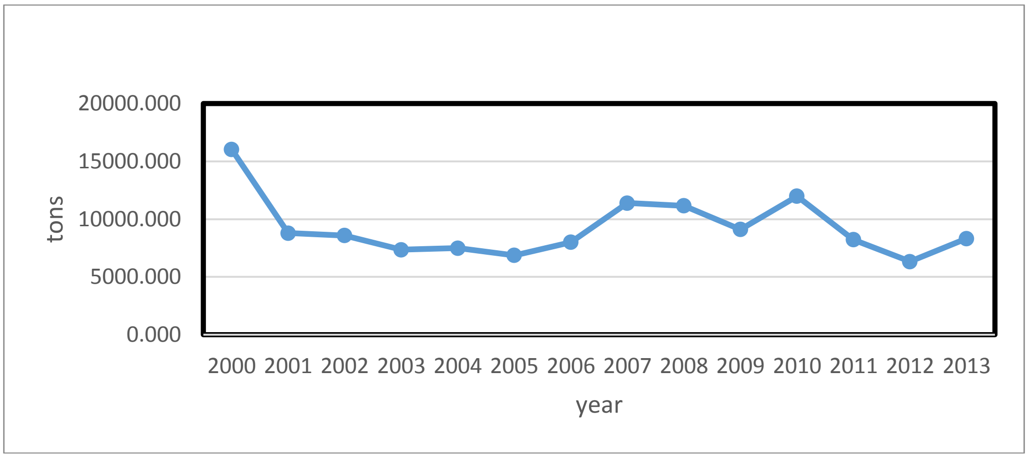


Fig. 6.3.2.3.1.1 Landings/catches of Whiting in the Black Sea after removal of age class 0 and 1 from the data.

6.3.2.3.2 Discards

Since the mid-1970s to the early 1990s in the waters of Bulgaria and the former USSR studies to assess by-catch of whiting in the trawl fishery sprat were performed (Prodanov et al, 1997). Part of by-catch was discarded into the sea, and the rest labeled as "sprat" (fraction of sprat in such landings usually exceed 90-95%). In any case, captured whiting was almost never reported in official fishing statistics. Although some of the whiting catch was landed (under the labelof sprat), it could only be formally considered a by-catch, and in fact acted as a "discard".. In these studies, no sampling was done to determine discard by ages, but it was known that discarding applied mainly to whiting aged less than two years. In the waters of Bulgaria in 1976-1987 whiting discards were at the highest and annually exceed 1,000 tons, maximum – 3860 tons (Table 6.3.2.3.2.1). In the absence of official landings of whiting in 1982-1993, discard was assumed to be 100%.

Table 6.3.2.3.2.1. Dynamics of the whiting discard (by-catch discarded into the sea plus landed whiting under the guise of sprat) in trawl fisheries sprat Bulgaria and former USSR in the Black Sea in 1975-1993

	Bulgaria		Ukraine	
Year	**Discard, tons**	**Discard, %***	**Discard, tons**	**Discard, %***
1975	300	39,8	N.A.	N.A.
1976	1338	78,0	85	79,5
1977	1917	89,8	800	100,0
1978	2506	86,0	2700	82,2
1979	2493	97,2	6500	36,4
1980	3860	99,2	2780	50,5
1981	2563	100,0	3970	61,1
1982	2750	100,0	6686	81,5
1983	1507	100,0	5419	69,5
1984	1711	100,0	5741	54,7
1985	1501	100,0	2316	46,3
1986	1118	100,0	2140	44,6
1987	1058	100,0	1736	38,6
1988	886	100,0	2277	50,6
1989	745	100,0	5409	90,2
1990	359	100,0	8478	96,3

1991	246	100,0	2576	99,1
1992	483	100,0	900	100,0
1993	620	100,0	500	100,0

* was calculated as the percentage of discard of the amount of official landed Whiting and discard

In Ukrainian waters the largest by-catch and discard of whiting was in 1978-1991 (1.7-6.7 thousand tons annually). Sampling whiting bycatch-at-sea during 1992-2002 in Ukraine waters was conducted (Shlyakhov, Charova, 2006). These estimates are based on the monitoring of data extracted in the process of sprat fisheries on board fishing vessels. In Ukrainian waters target fisheries for whiting and sprat with midwater trawls are permitted approximately at 60% of the shelf zone. As sprat trawl fisheries are more profitable for economic reasons, fishermen try to conduct fishing in areas of the densest concentrations, occurring usually in depth ranges of 30-60 m and less. Between 1990-1994 and 2005-2009 an Ukrainian shift of the trawl fishery towards shallow coastal waters has occured (Shlyakhov, Shlyakhova, 2011)(Table 6.3.2.3.2.2). This process was accompanied by an increase in the discard of whiting aged 0 + and 1 with respect to total landings (Table 6.3.2.3.2.3). The average for the period 1994-2002 relative value of Ukrainian "discard" in the total the Black Sea countries catch of whiting for different ages varied from 2.2% to 12.5% (Figure 6.3.2.3.2.1.).

Table 6.3.2.3.2.2 Dynamics of the Whiting discard (by-catch discarded into the sea plus landed whiting under the guise of sprat) in trawl fisheries sprat Bulgaria and former USSR in the Black Sea in 1975-1993

	Romania		Ukraine	
Year	**Discard, tons**	**Discard, %**	**"Discard", tons**	**"Discard", %**
1994	N.A.	N.A.	336	84,0
1995	N.A.	N.A.	583	97,2
1996	N.A.	N.A.	1097	99,7
1997	N.A.	N.A.	971	97,1
1998	N.A.	N.A.	945	94,5
1999	N.A.	N.A.	632	97,2
2000	N.A.	N.A.	930	97,9
2001	N.A.	N.A.	982	98,2
2002	N.A.	N.A.	1791	99,5
2003-2010	N.A.	N.A.	N.A.	N.A.
2011	0,1	99,6	N.A.	N.A.
2012	0,4	97,3	N.A.	N.A.
2013	N.A	19,9	N.A	N.A

Table 6.3.2.3.2.3. Percentage discard rate of the Black Sea Whiting by age class and year in 1994-2013 (1994 - 2002 – data from midwater trawl sprat fishery for Ukrainian waters, 2011 - 2013 – data from pound nets fishery for Romanian waters, 2003 - 2010 – data not available)

AGE	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1994	3.13	1.00	1.64	0.07	0.69	10.61	100.00
1995	4.08	1.57	7.73	0.98	2.21	0.64	1.58
1996	7.88	2.58	2.16	2.38	3.63	6.10	5.12
1997	7.74	7.58	2.66	2.70	35.47	93.84	100.00
1998	20.53	5.60	5.60	5.60	5.60	5.60	46.57
1999	14.61	4.36	3.35	3.27	3.33	4.28	58.13
2000	31.17	3.03	3.03	4.13	1.76	3.96	1.37

2001	18.20	12.43	4.09	4.09	5.55	2.39	3.36
2002	88.68	43.80	15.37	3.01	0.98	0.52	0.41
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	1.22	0.78	0.43	0.18	0.29	0.04	0.00
2012	37.10	3.04	0.38	0.00	0.00	0.00	0.00
2013	39.20	3.65	0.42	0.00	0.00	0.00	0.00

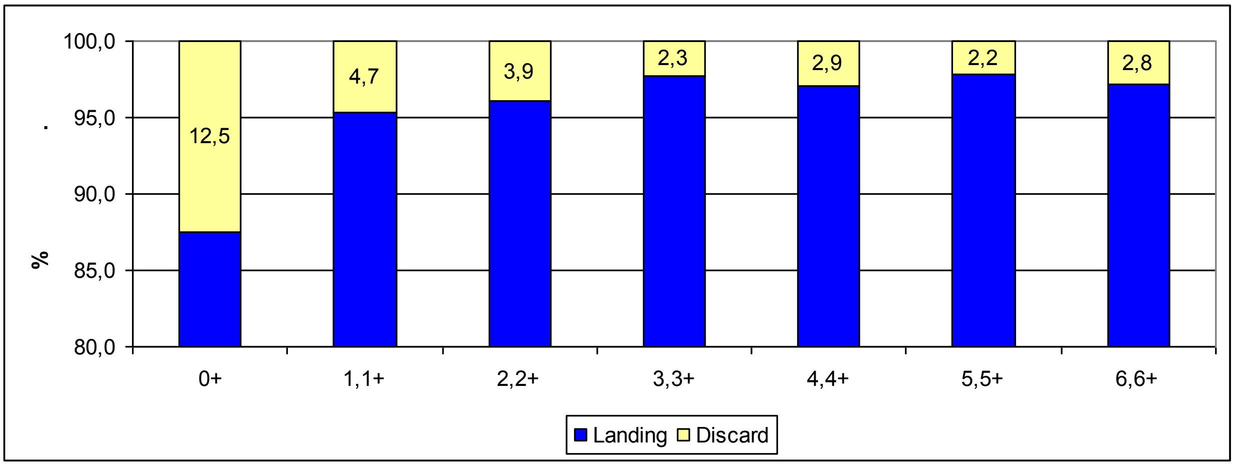


Fig. 6.3.2.3.2.1. Ukrainian discard in the total the Black Sea countries catch of Whiting the average for the period 1994-2002 (without discards in the waters of other Black Sea countries)

In Turkish waters (Samsun shelf area) the rate of whiting landing (marketed fish) and discards observed in 2005-2011 in experimental surveys and commercial vessels were pointing out the heavy exploitation. In accordance with data obtained the average discard value in different fishing seasons ranged between 30% and 50% (Fig. 6.3.2.3.2.2) for age class 0 and 1 (Zengin et al.,2011).

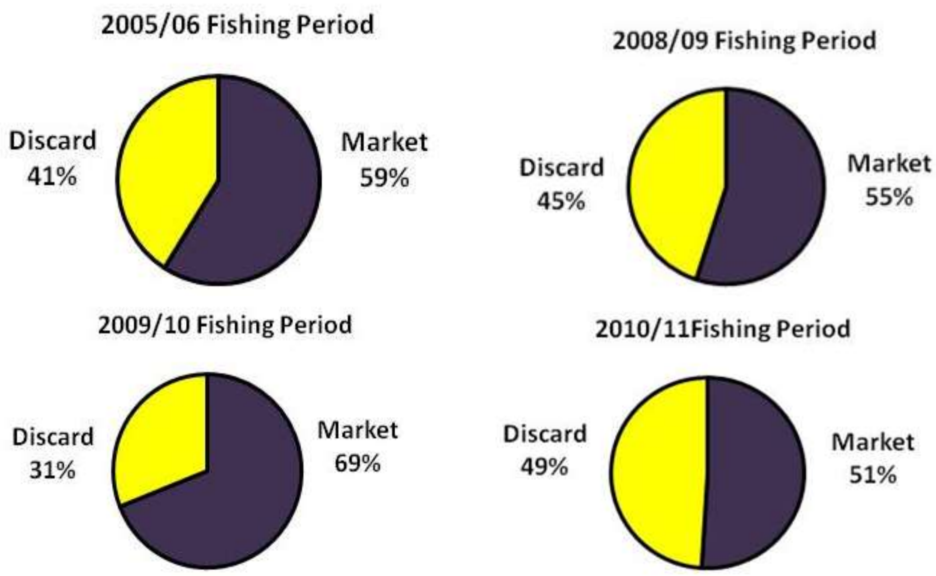


Fig. 6.3.2.3.2.2. The composition of marketed and discard Whiting as a biomass in Samsun shelf area

In 2012, for the first time were presented to the EWG the Bulgarian (1975-1993) and Ukrainian (1976-2002) data of discard whiting on trawl fishery of sprat, the Turkish (2005-2011) and Romanian (2011-2013) data of discard for the target whiting fishery. These data show that a discard is an important part of the whiting catches in ages 0 + and 1, and therefore they should be included in the data set for stock assessment. However, this seems impossible because of the incomplete data for discard by age in 1994-2002 and 2011-2012, and the total absence in 2003-2010.

6.3.2.4 Fishing effort

Information on fishing effort was not provided

6.3.2.5 Commercial CPUE

The monthly distribution of CPUE and landings with bottom trawls in whiting fishery for the southern coast of Black Sea in 2011 was represented in Fig. 6.3.2.5.1. The CPUE values seem to be higher for Samsun shelf area (mean 213.2 kg/vessel/day) than the western coast (159.3 kg/vessel/day). It is known that Samsun shelf is wider and more productive when compared to the western coasts. This fact enhanced the bottom trawl fishery in the region and the number of vessels in the fleet increased in Samsun (Gümüş and Zengin, 2012).

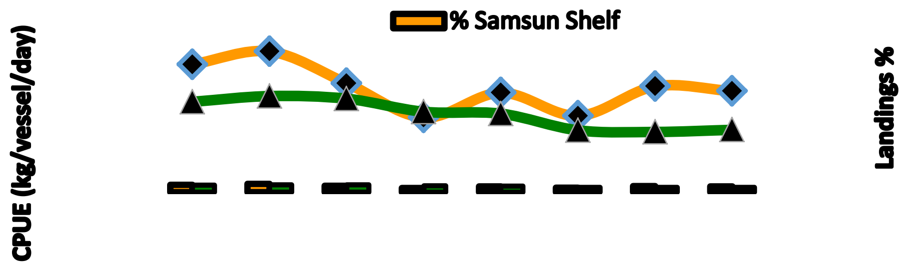


Fig. 6.3.2.5.1. The distribution of CPUE and landings in 2011 for Samsun Shelf and the western Black Sea coast in Whiting fishery (Zengin et al., 2011)

In accordance with the Turkish research CPUE fishing vessels trawling for whiting by age in 2009-2013 have a clearly pronounced negative trend, except for the 5-year-old fish (Table 6.3.2.5.1).

Table 6.3.2.5.1 CPUE for whiting by age according to Turkish surveys of the fishing fleet (trawls)

Year	Country	Age									TOTAL
		0	1	2	3	4	5	6	7	8	
		kg/h									
2009	Turkey	116,1	26,6	50,2	15,7	3,6	0,4	0,0	0,0	0,0	212,7
2010		0,4	12,9	19,6	6,2	1,3	0,2	0,0	0,0	0,0	40,7
2011		2,8	18,5	20,6	8,5	1,2	0,6	0,0	0,0	0,0	52,1
2012		0,3	7,7	15,6	6,1	0,8	0,5	0,1	0,0	0,0	31,0
2013											
N/h											
2009	Turkey	17131,3	3922,0	7404,8	2321,8	533,4	62,8	0,0	0,0	0,0	31376,1
2010		32,0	1130,1	1711,9	544,4	117,0	20,6	0,0	0,0	0,0	3556,1
2011		256,5	1697,1	1890,8	780,8	110,8	58,9	0,0	0,0	0,0	4794,9
2012		26,9	615,2	1244,1	483,8	62,2	39,1	4,2	0,5	0,9	2476,8
2013											

6.3.3 Scientific surveys

6.3.3.1 Method 1 Pelagic survey in EU waters

Geographical distribution patterns of whiting in Romanian waters of the Black Sea in 2013 are given in Table 6.3.3.1.1 and Figures 6.3.3.1.1 to 6.3.3.1.3.

During the spring season 33 pelagic trawl hauls were performed, with a duration of 30 min./haul, at depths between 13.8 m and 60 m, is covered almost entirely continental shelf Romanian coast, between Sfantu Gheorghe and Vama Veche. The total catch of whiting caught was 138.50 kg. The following quantities were caught: 4.197 kg / haul; 7.631 kg / hour of trawling.

The dominant length classes are those of 75 - 110 mm / 3.026 – 8.483 g (Fig. 6.3.3.1.1). Females predominated (56.76 %), than males (43.24%). The average body length was 93.76 mm and the average mass of 18.77 g (Maximov and Radu, 2013).

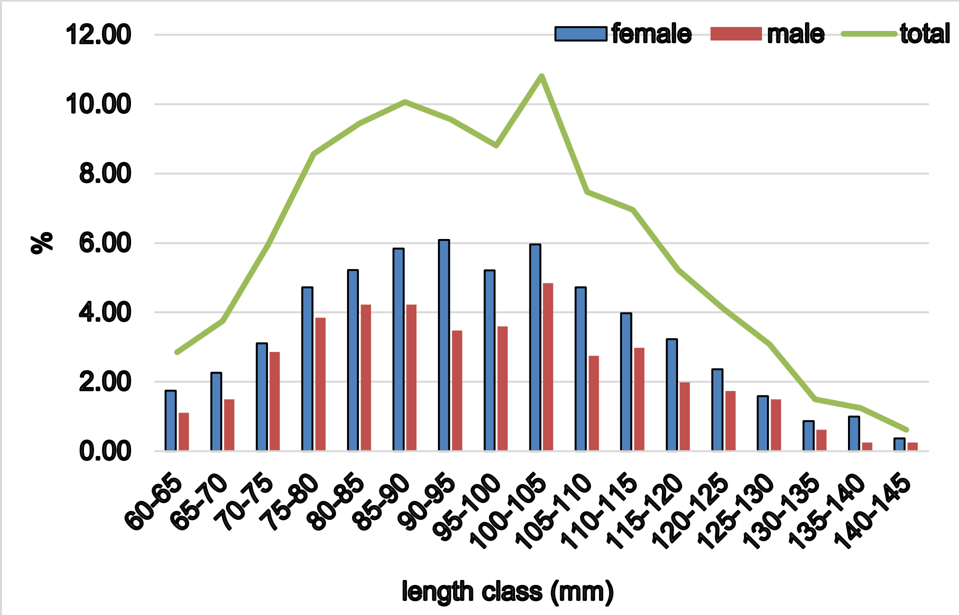


Fig. 6.3.3.1.1 Structure by lengths and mass cards of whiting during spring survey (pelagic trawl)

Age composition of turbot catches indicates the presence of individuals from 0 to 3 years. Most of the individuals caught are 1 years old (39.5% of all specimens analyzed), 2 years (32.4%) and 0 years (18.3%), followed closely by those of 3 years (9.1%) and 4 years (0.7%)(Fig. 6.3.3.1.2)(Maximov and Radu, 2013).

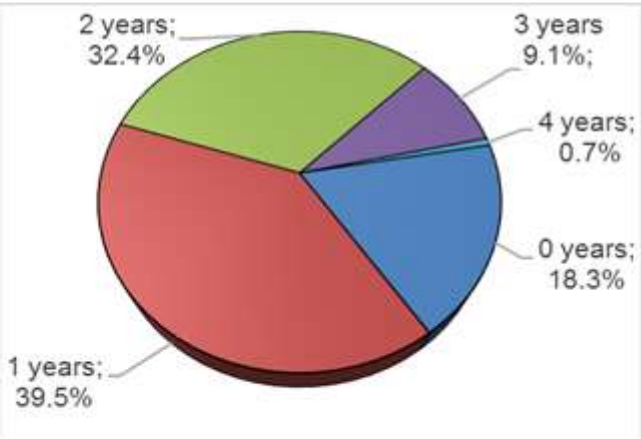


Fig. 6.3.3.1.2 Structure by age composition of whiting during spring survey (pelagic trawl)

During the research from spring survey 2013 (pelagic trawl), sweeping area procedures were conducted on an surface of 1,600 Nm^2., the distribution of whiting agglomerations was different. The average values of whiting catches, were situated in the limits between 0.000 and 3.269 t/Nm^2. The scientific research organized in spring seson (June 2013), revealed that whiting had a flat distribution in large area between Constanta – Vama Veche, agglomerations reaching an average of 0.00 - 1.078 t / Nm^2 / depth 0 – 30 m, respectively 0.00 – 3.269 t / Nm^2 / depth 30 -50 m. Estimated biomass of whiting agglomerations for spring pelagic survey in the investigated area was of about **464.224 tones**, and the estimated one for the Romanian platform was considered only up to distance of 50 Nm, was about **1,450.699 tones** (Table 6.3.3.1.1 and Fig. 6.3.3.1.3)(Radu and Maximov, 2013).

Table 6.3.3.1.1 Assessment of whiting agglomerations in June 2013, pelagic trawl survey, Romanian area

Depth range (m)	***0 - 30m***	***30 – 50m***	***50-70 m***	***Total***
Investigated area (Nm^2)	625	887.5	87.5	1600
Variation of the catches (t/ Nm^2)	0.00 – 1.078	0.00-3.269	0.00	0.00 – 3.269
Average catch (t/ Nm^2)	0.242818	0.389	0.00	0.2914
Biomass of the fishing agglomerations (t)	151.7614	345.2375	0.00	464.2235
Biomass extrapolated the Romanian shelf (t)				1450.699

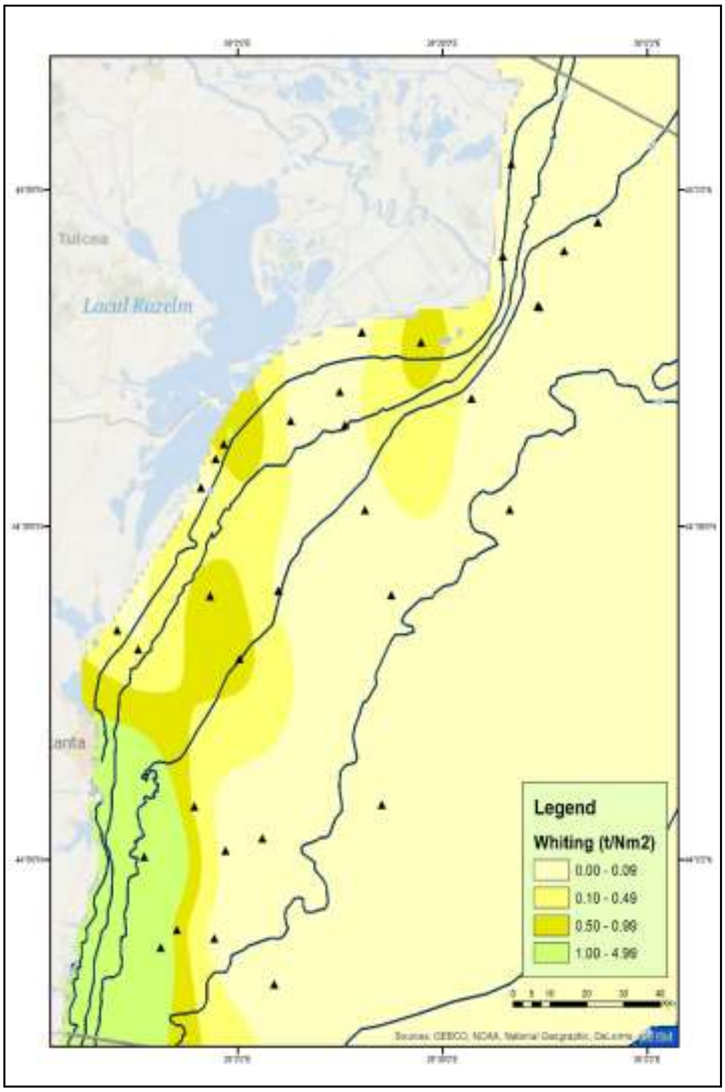


Fig. 6.3.3.1.3. Distribution of the whiting agglomerations at Romanian littoral in spring 2013 (pelagic trawl)

6.3.3.2 Method 2 Bottom survey in EU waters

6.3.3.2.1 Geographical distribution patterns

Geographical distribution patterns of whiting in Romanian waters of the Black Sea in 2013 are given in table 6.3.3.2.1.1 to 6.3.3.2.1.2 and figures 6.3.3.2.1.1 to 6.3.3.2.1.6.

During the spring season 41 demersal trawl hauls were performed, with a duration of 60 min./haul at depths between 13.8 m and 80 m. The survey covered almost entirely the Romanian continental shelf Romanian, between Sfantu Gheorghe and Vama Veche. The total catch of whiting caught was 534.26 kg, was made following quantity: 13.356 kg / haul; 13.356 kg / hour of trawling.

The analysis of structure by lengths and mass cards of whiting during spring survey, has highlighted the presence of mature specimens and a high homogeneity of cards. The length of turbot individuals are within the limits of classes of length 55 - 160 mm / 1.115 – 32.09 g). The dominant classes are those of 75 - 110 mm / 3.026 – 8.483 g (Fig. 6.3.3.2.1.1). Females predominated - 58.26 %, than males (41.74%). The average body length was 95.96 mm and the average mass of 19.98 g (Maximov and Radu, 2013).

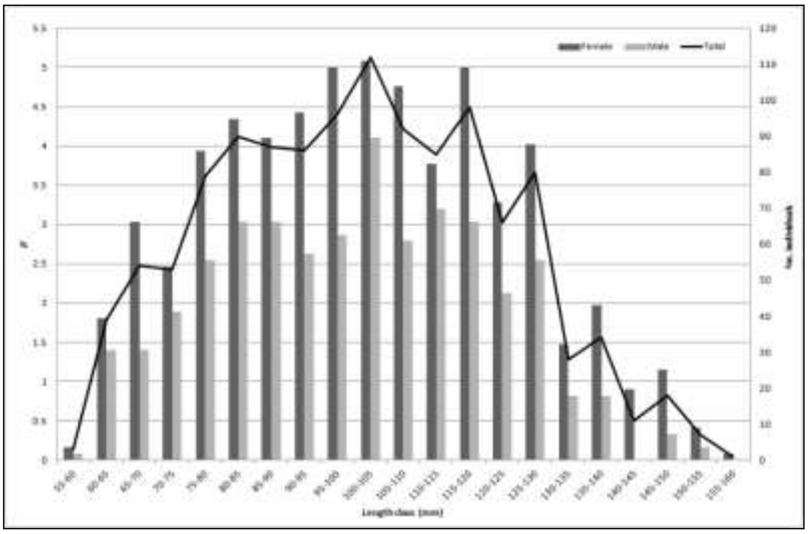


Fig. 6.3.3.2.1.1 Structure by lengths and mass cards of whiting during spring survey (bottom trawl)

Age composition of whiting catches indicates the presence of individuals from 0 to 3 years. Most of the individuals caught are 1 years old (43% of all specimens analyzed), 2 years (31%) and 0 years (19%), followed closely by those of 3 years (7%) (Fig. 6.3.3.2.1.2) (Maximov and Radu, 2013).

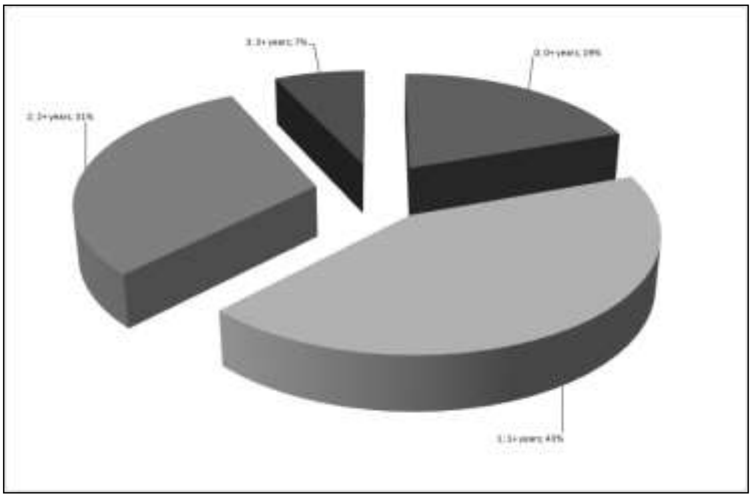


Fig. 6.3.3.2.1.2 Structure by age composition of whiting during spring survey

During the research from spring survey 2013 (bottom trawl), sweeping area procedures were conducted on an surface of 3,300 Nm^2., the distribution of whiting agglomerations was different. The average values of whiting catches, were situated in the limits between 0.362944 and 1.145056 t/Nm^2. The scientific research organized in spring seson (May - June 2013), revealed that whiting had a flat distribution in large area between Gura Portita – Cap Tuzla, agglomerations reaching an average of 0.73633 - 1.145056 t / Nm^2 / depth 0 – 30m and 30 -50 m, respectively 0.362944 - 0.356379 t / Nm^2 / depth 50 – 70 m and 70 -100 m. Estimated biomass of whiting agglomerations for springsurvey in the investigated area was of about 2,419.94 tones, and the estimated one for the Romanian platform was considered only up to distance of 50 Nm, was about 3,666.57 tons (Table 6.3.3.2.1.1 and Fig. 6.3.3.2.1.1) (Radu and Maximov, 2013).

Table 6.3.3.2.1.1 Assessment of whiting agglomerations in the period May-June 2013, demersal trawl survey, Romanian area

Depth range (m)	**0 – 30 m**	**30 – 50 m**	**50-70 m**	**70-100 m**	**Total**
Investigated area (Nm^2)	650	1225	1350	50	**3300**
Variation of the catches (t/ Nm^2)	0.119-1.496	0.00-5.940	0.00-4.158	0.119-0.594	**0.00-5.940**
Average catch (t/ Nm^2)	0.73633	1.145056	0.362944	0.356379	**0.73331**
Biomass of the fishing agglomerations (t)	478.6167	1402.693	489.975	26.72844	**2419.94**
Biomass extrapolated the Romanian shelf (t)					**3666.57**

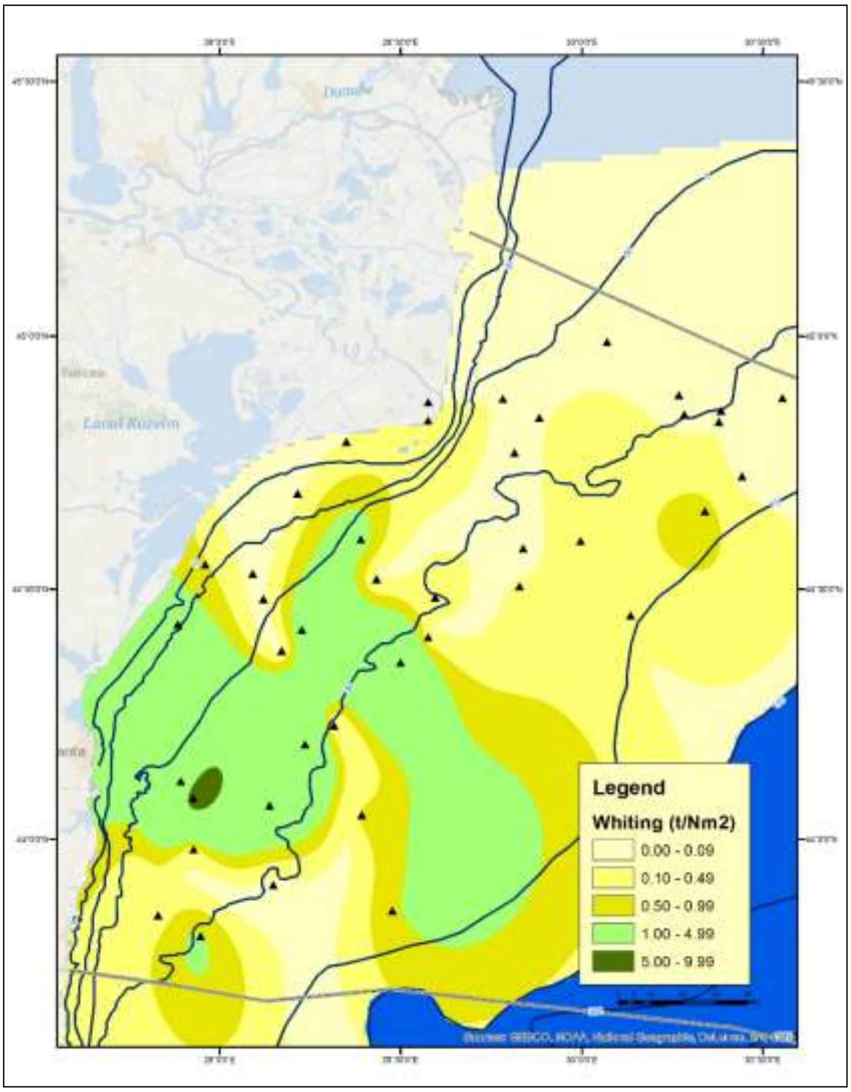


Fig. 6.3.3.2.1.3. Distribution of the Whiting agglomerations at Romanian littoral in spring 2013

The autumn season was made 40 demersal trawl haul(bottom trawl). In depths between 20 m and 65 m, is covered almost entirely continental shelf Romanian coast, between Sfantu Gheorghe and Vama Veche. The total catch of whiting caught was 1,370.5 kg, was made following quantity: 36.066 kg / haul; 36.066 kg / hour of trawling.

The analysis of structure by lengths and mass cards of turbot during spring survey, has highlighted the presence of mature specimens and a high homogeneity of cards. The length of whiting individuals are within the limits of classes of length 65 - 175 mm / 2.156 – 46.14 g. The dominant classes are those of 85 - 125 mm / 4.25 – 12.22 g (Fig. 6.3.3.2.1.4). The ratio per sexes indicates a dominance of females (58.77%), than males (41.23%). The average body length was 108.20 mm and the average mass of 9.66 g (Maximov and Radu, 2013).

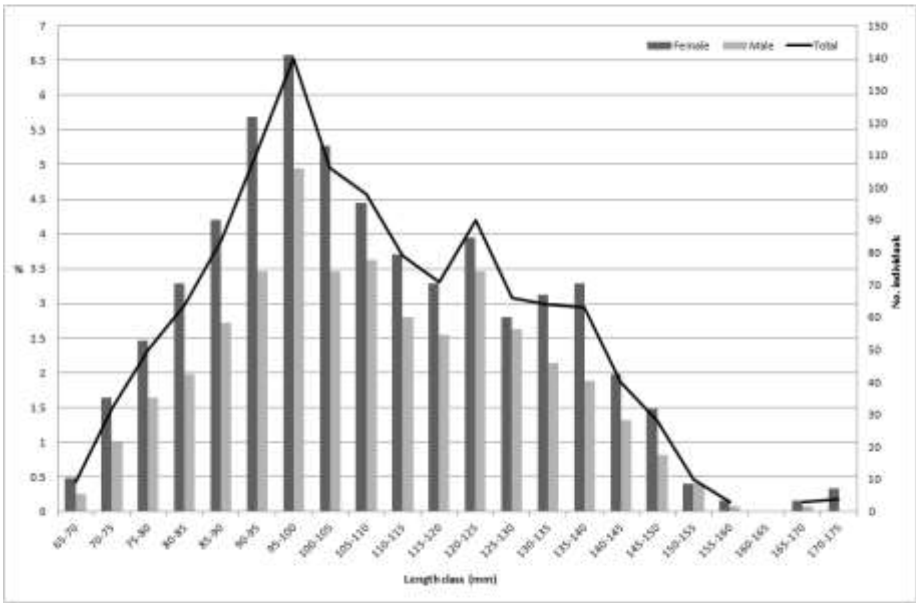


Fig. 6.3.3.2.1.4 Structure by lengths and mass cards of whiting during autumn survey

Age composition of whiting catches indicates the presence of individuals from 0 to 4 years. Most of the individuals caught are 1 years old (41,914 % of all specimens analyzed) and 2 years (33,828 %), followed closely by those of 0 years (12,376 %), 3 years (8,086 %) and 4 years (2,805%) (Fig. 6.3.3.2.1.5)(Maximov and Radu, 2013).

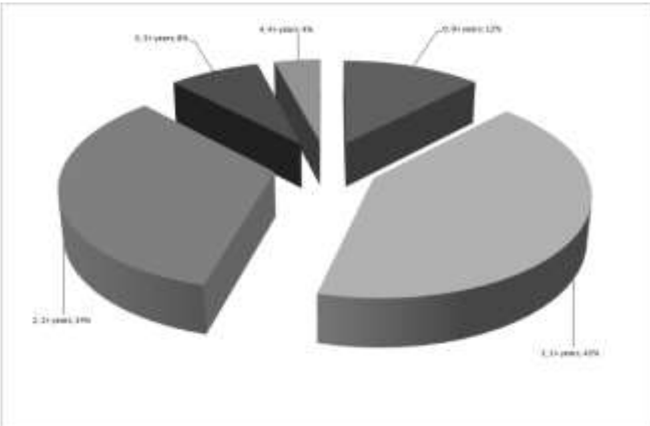


Fig. 6.3.3.2.1.5 Structure by age composition of whitingt during autumn survey

During 40 sweeping area procedures conducted on an area of 2.150 Nm^2, the distribution of whiting agglomerations was different. The average values of whiting catches, were situated in the limits between 0.712667 and 6.13825 t/Nm^2. The scientific research organized in autumn (October 2013), revealed that whiting had a flat distribution in large area between Sulina - Sf. Gheorghe, with a greater density in area Periteasca – Cap Tuzla and Mangalia, agglomerations reaching an average of 0.00 - 28.510 t / Nm^2 / depth 0 - 100 m. Estimated biomass of whiting agglomerations for autumn survey in the investigated area was of about 8,512.651 tons, and the estimated one for the Romanian platform was considered only up to distance of 50 Mm, was about 19,796.86 tons (Table 6.3.3.2.1.2 and Fig. 6.3.3.2.1.6) (Radu and Maximov, 2013).

Table. 6.3.3.2.1.2 Assessment of whiting agglomerations in October 2013, demersal trawl survey, Romanian area

Depth range (m)	***0 - 30m***	***30 – 50m***	***50-70 m***	***Total***
Investigated area (Nm^2)	625	1075	450	**2150**
Variation of the catches (t/ Nm^2)	0.00-2.851	0.00-28.510	0.00-11.404	**0.00-28.51**
Average catch (t/ Nm^2)	0.712667	6.13825	2.238	**3.9593**
Biomass of the fishing agglomerations (t)	445.4167	6598.619	1007.1	**8512.651**
Biomass extrapolated the Romanian shelf (t)				**19796.86**

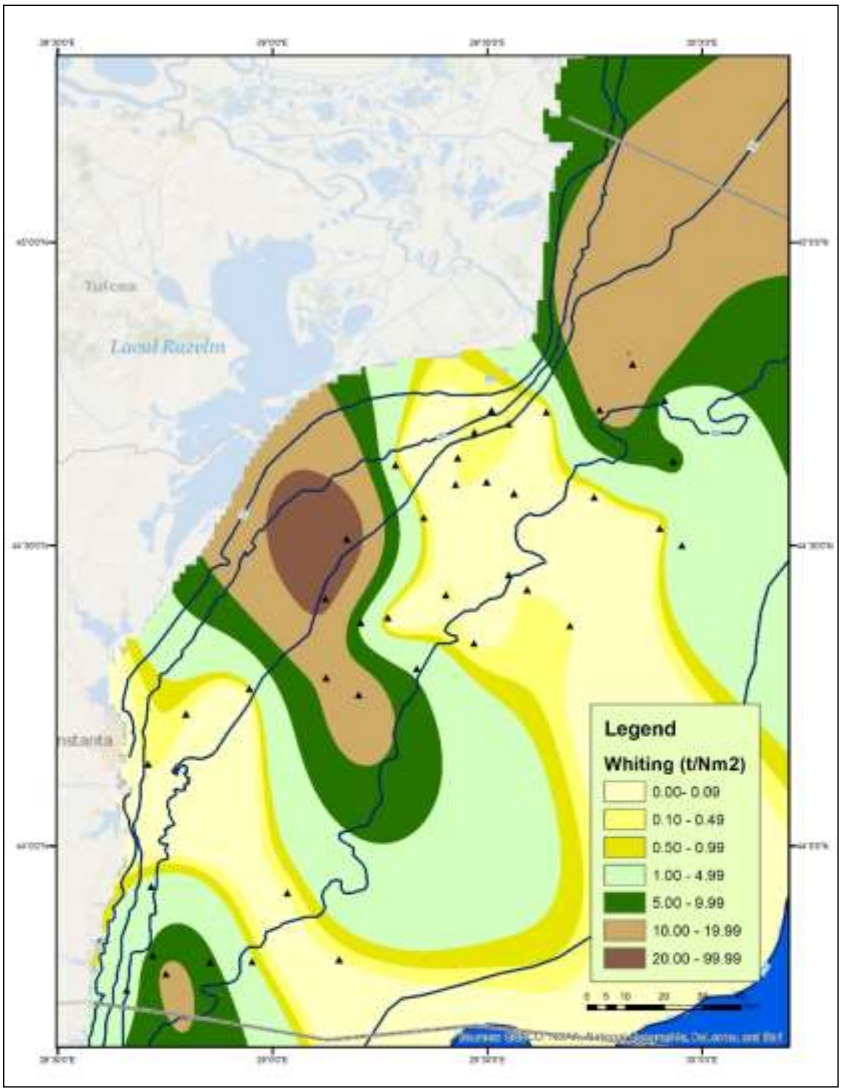


Fig. 6.3.3.2.1.6 Distribution of the whiting aggregations on Romanian littoral in autumn 2013

The CPUE values for the four quarters of 2013 starting with January were determined as 50.27 kg/h, 25.31kg/h, 29.80 kg/h and 43.10 k/h. The average CPUE was 44.36 kg/h for the whole year (Gumus et al., 2013).

The distribution of whiting aggregations along the Turkish coasts is presented in Figure 6.3.3.2.1.7.

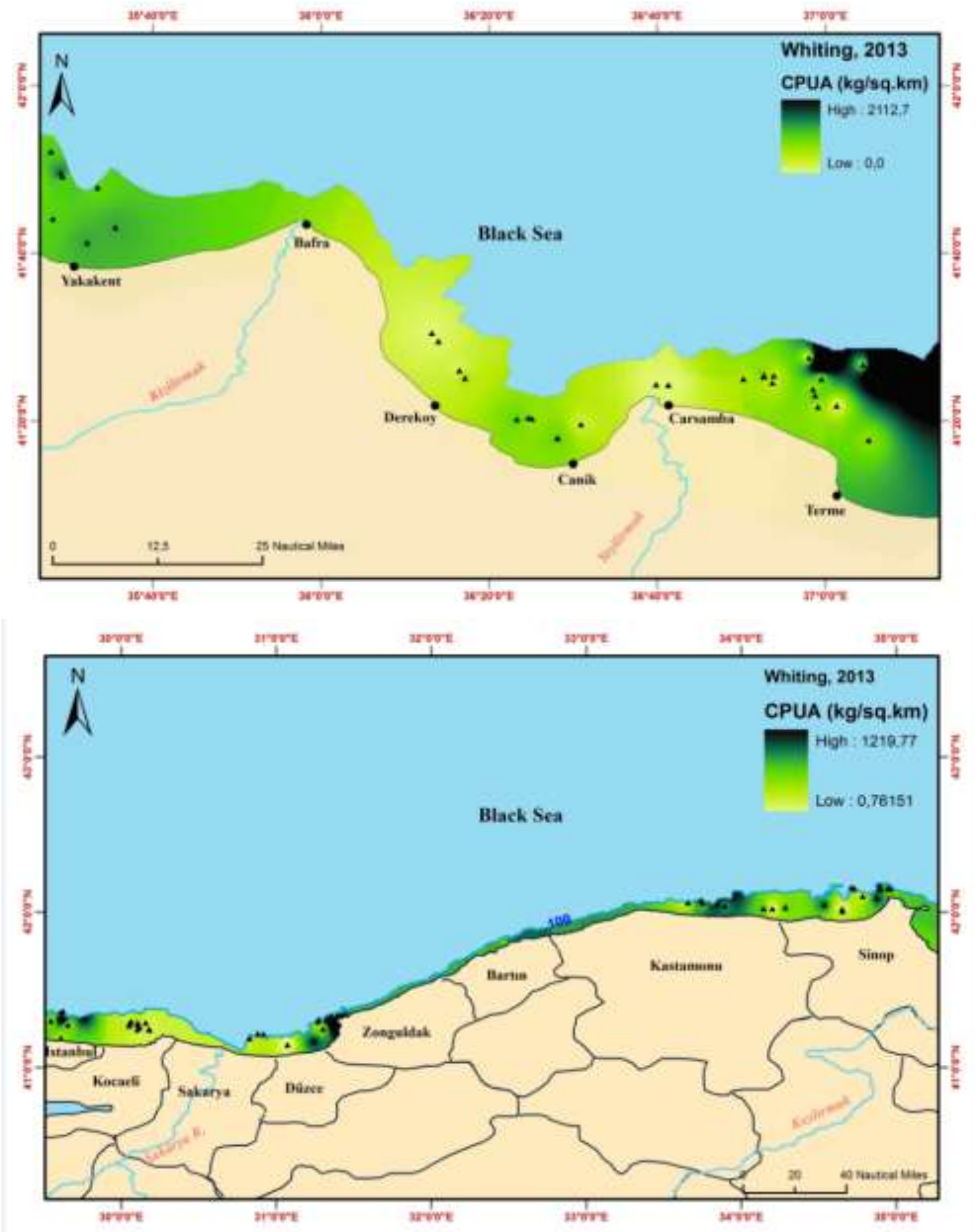


Fig. 6.3.3.2.1.7 The distribution maps of abundance indices along Samsun Shelf area (upper) and west Black Sea Turkish coasts (lower) for 2013.

6.3.3.2.2 Abundance and biomass

In Romanian waters the swept area method was applied for stock assessment of whiting. Results for estimated whiting biomasses and abundance in spring and autumn of 2013 in Romanian waters are given in Tables 6.3.3.2.2.1 - 6.3.3.2.2.2.

Table 6.3.3.2.2.1. Assessment of whiting abundance and biomass indexes in the Romanian area in spring and autumn 2013, sampling gear bottom trawl 22/27-34 with horizontal opening of 13 m

No	***Season***	***No. stations***	***depth range (m)***	***kg / trawl***	***t / Mm²***
1	Spring	41	13.8 - 80	13,365	1.11108
2	Autumn	40	20 - 65	36,066	9.20784

Table 6.3.3.2.2.2. Indices of abundance of whiting according to the Romanian research trawl surveys in 2008-2013 ($N \times 10^{-6}$)

Year	0^+	$1;1^+$	$2;2^+$	$3;3^+$	$4;4^+$	$5;5^+$	TOTAL
2007	47.329	989.385	449.264	66.062	0.000	0.000	**1552.041**
2008	71.273	961.932	401.439	41.103	0.000	0.000	**1475.747**
2009	85.344	431.119	286.875	65.124	18.169	0.000	**886.631**
2010	207.063	1145.076	483.517	51.510	14.561	0.000	**1901.727**
2011	452.007	1152.959	791.570	72.781	7.459	8.690	**2485.466**
2012	10.083	612.631	252.230	33.361	0.000	0.000	**908.231**
2013	568.889	1491.600	1107.715	240.506	57.814	0.000	**3466.524**

In Turkey the survey period in 2012 included 7 months (from January to April and from September). Abundance indices were estimated by 'swept area method' for the period of whiting fishing seasons (January-May) from commercial vessels (Sparre and Venema, 1992). The trawl survey samplings conducted is generally below 40 m (minimum 24.7 m, maximum 113.0 m) depths along the SSA and WBS littorals zones. In 2013 the mean catches per unit effort (CPUE) and abundance index were estimated respectively as 31.03 kg/km^2 and 1111×10^{-3} kg/km^2 (Table 6.3.2.2.3 - 6.3.2.2.4). The stock is localized under the thermocline layer which is started about 40 m.

Table 6.3.2.2.3. Descriptive data regarding (kg/h) of whiting for 2011 to 2013 in the Samsun shelf area (SSA) and West Turkish Black Sea

Region	No of hauls	Minimum	Maximum	Mean	Std. Error	Std. Deviation
CPUE/GENERAL	102	0.00	150.00	31.03	2.72	27.46
CPUE/SSA (EBS)	60	0.00	150.00	30.59	3.64	28.20
CPUE/ WBS	42	0.00	100.00	31.66	4.12	26.69

Table 6.3.2.2.4. The indices of abundance (($N \times 10^{-3}$) and average whiting CPUE (kg/h) on to the Turkish research trawl surveys in 2009 - 2013

Age	2009	2010	2011	2012	2013
0	1015.1	14.4	115.6	12.0	
1	232.4	507.1	765.1	276.0	
2	438.7	768.1	852.4	558.2	
3	137.6	244.3	352.0	217.1	
4	31.6	52.5	50.0	27.9	
5	3.7	9.3	26.5	17.5	
6	0.0	0.0	0.0	1.9	
7	0.0	0.0	0.0	0.2	
8	0.0	0.0	0.0	0.4	
TOTAL	**1859.1**	**1595.5**	**2161.5**	**1111.3**	
kg/h	**212.7**	**56.7**	**52.1**	**31.0**	

6.3.4 Assessment of historical parameters

6.3.4.1 Method 1: XSA

STECF EWG 14 14 applied XSA for assessment of whiting stock in Black Sea.

6.3.4.2 Justification

The data (1994-2013) of landings, catch at ages, weights and maturity at age are considered appropriate for assessing the stock using XSA. Turkish CPUE and Romanian survey data were used for tuning the assessment.

6.3.4.3 Input parameters

Recent data from national statistics by countries in 2013 were added to the historic catch at age data set compiled during the previous meetings (Sampson et.al, 2013) for the period 1994 – 2012. The catch at age data was corrected to the official landings (SOP corrections). These represented officially reported landings and do not include any discards.

Due to poorly documented discarding rates of fish of ages between 0 and 1, it was deemed reasonable to exclude these first two year classes from the XSA in order to reduce the bias introduced by the poorly documented discard rate. The assessment was thus ran using ages 2 to 6 for both the catch matrix and the tuning indexes.

The mean weights at ages in the stock for the period 1994-2013 were assumed equal to the catch weights at age in the landings due to lack of data. For 2013, weights at age were estimated as an arithmetic mean calculated across countries.

Natural mortality (M) vector applied in all ages and years was constant and the same as assessment in 2013 (Sampson et al., 2013).

Maturity ogives applied are the same used in the assessment from 2013 (Sampson et.al., 2013).

The XSA was tuned with 2 series – commercial CPUE from Turkey (ages 0 – 6 over the period 2009 – 2013) and survey index from Romania (ages 0 – 4, over the period 2007 – 2013). The both tuning series were recalculated, compared to the assessment in 2013 and in Romanian survey index, the year 2007 was added.

Trends in the CPUE series are shown below in Fig. 6.3.4.3.1. Romanian survey increases in last year and the Turkish CPUE – keep the same trends as last years.

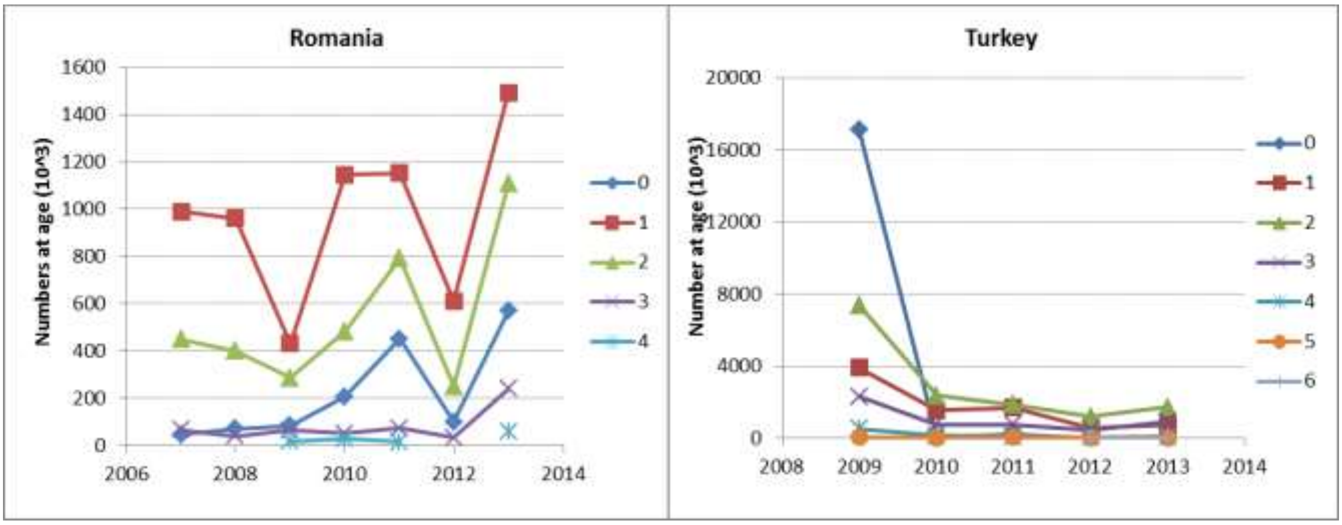


Figure 6.3.4.3.1. Whiting in the Black Sea. Trends in the Romanian survey (2007 – 2013) and Turkish CPUE (2009 – 2013) series at age.

The exploration analysis of Turkish tuning series is presented on Fig. 6.3.4.3.1.2.

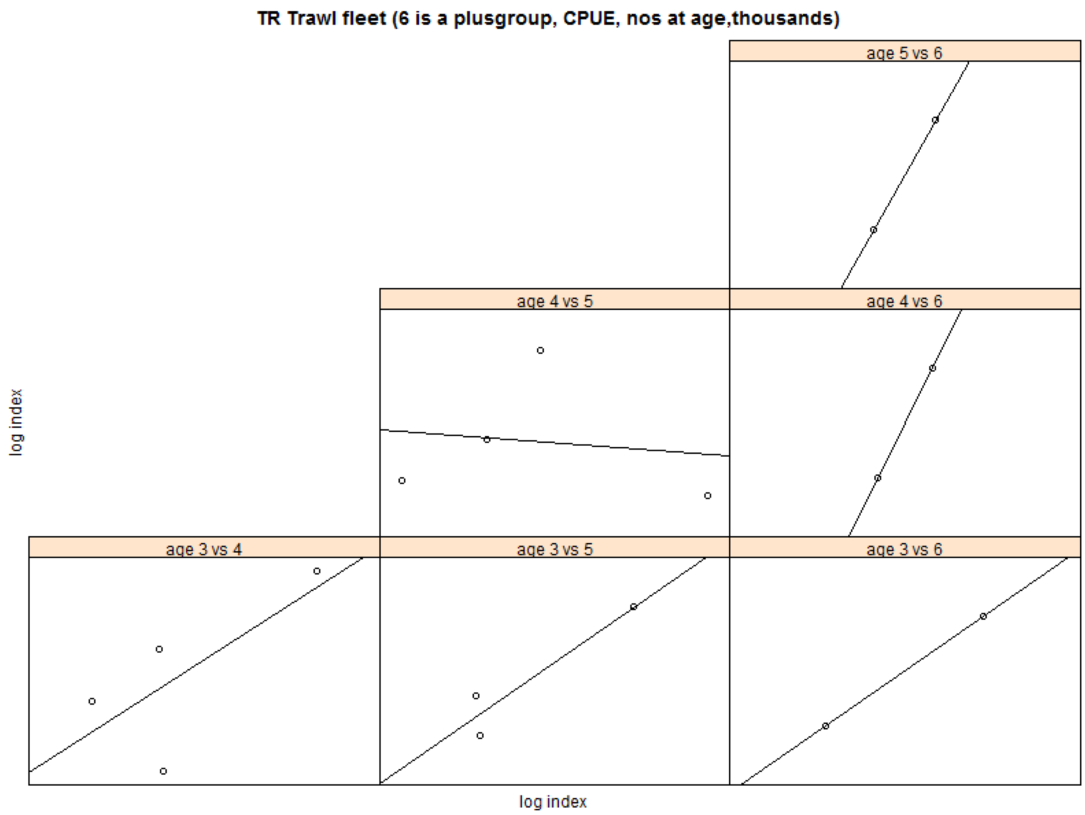


Fig. 6.3.4.3..2. Internal consistency of Turkish CPUE data over the period 2009 – 2013.

Table 6.3.4.3.1. Input parameters for the XSA.

>	bsw.stk									
An	object	of	class	FLStock						
Slot	catch:									
An	object	of	class	FLQuant						
	unit	=	unique	season	=	all	area	=	unique	
age/year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
	8091.3	6609.3	10093.6	7076.8	8337.5	7765	8557.4	3917.9	7734.2	6212.3
age/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
	5460.8	2299.7	4948.9	7380.2	7541.4	6617.1	10174	6780.3	5748.7	7647.9
units:	NA	NA								
Slot	catch.n:									
An	object	of	class	FLQuant						
	unit=	unique	season=	all	area	=	unique			
age/year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**		
2	1.17E+05	5.05E+04	3.10E+05	2.46E+05	2.19E+05	2.03E+05	2.03E+05	9.84E+04		

3	1.13E+05	8.69E+04	6.15E+04	5.31E+04	4.98E+04	4.53E+04	4.42E+04	2.96E+04
4	2.09E+04	1.73E+04	1.72E+04	1.24E+03	2.53E+04	2.34E+04	2.31E+04	6.43E+03
5	3.29E+02	9.74E+03	1.76E+03	7.92E+00	2.84E+03	3.41E+03	4.39E+03	2.82E+03
6	3.27E+00	1.83E+03	9.23E+02	3.31E+00	6.66E+01	6.75E+01	3.48E+03	1.21E+03

age/year	2002	2003	2004	2005	2006	2007	2008	2009
2	7.40E+04	8.44E+04	1.44E+05	1.63E+04	1.54E+05	1.88E+05	1.90E+05	1.93E+05
3	3.96E+04	3.25E+04	4.49E+04	3.84E+04	1.76E+04	3.69E+04	3.68E+04	6.04E+04
4	3.65E+04	2.60E+04	1.04E+04	6.10E+03	1.05E+04	1.47E+04	2.67E+04	1.38E+04
5	1.75E+04	1.79E+04	1.20E+03	1.52E+03	6.09E+03	1.10E+04	8.00E+03	1.63E+03
6	5.61E+03	2.28E+03	2.30E+00	2.61E+02	3.03E+02	2.97E+03	7.82E+02	1.84E+00

age/year	2010	2011	2012	2013
2	3.01E+05	2.09E+05	1.64E+05	2.60E+05
3	9.57E+04	8.59E+04	6.34E+04	1.42E+05
4	2.06E+04	1.22E+04	8.20E+03	1.28E+04
5	3.75E+03	6.48E+03	5.13E+03	4.62E+03
6	1.80E+00	2.11E+00	7.38E+02	4.74E+02

units:	NA						
Slot	catch.wt:						
An	object	of	class	FLQuant			
	unit=	unique	season=	all	area	=	unique

age/year	1994	1995	1996	1997	1998	1999	2000	2001
2	0.020382	0.020382	0.020382	0.02038	0.020382	0.020382	0.021875	0.020582
3	0.037392	0.037392	0.037392	0.03739	0.037392	0.037392	0.03944	0.037032
4	0.069215	0.069215	0.069215	0.06922	0.069215	0.069215	0.068103	0.0651
5	0.089646	0.089646	0.089646	0.08965	0.089646	0.089646	0.086428	0.081952
6	0.123577	0.142178	0.142156	0.12358	0.141582	0.141589	0.122144	0.122146

age/year	2002	2003	2004	2005	2006	2007	2008	2009
2	0.023215	0.020971	0.021096	0.01983	0.0204	0.020343	0.02043	0.019057
3	0.038541	0.038171	0.038728	0.03833	0.036835	0.038218	0.035574	0.033669
4	0.061075	0.056156	0.055832	0.05744	0.059149	0.058069	0.060426	0.056435
5	0.083937	0.081952	0.081952	0.08013	0.081952	0.08239	0.081707	0.078748
6	0.142193	0.122145	0.121981	0.11977	0.122154	0.12853	0.118179	0.109729

age/year	2010	2011	2012	2013
2	0.018603	0.016111	0.017116	0.01352
3	0.032816	0.028788	0.032731	0.02404
4	0.05531	0.043051	0.052603	0.03895
5	0.080323	0.0639	0.076084	0.04284
6	0.123577	0.123577	0.070717	0.06267

units:	NA
Slot	discards:

An	object	of	class	FLQuant						
	unit	=	unique	season	=	all	area	=	unique	

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
all	0	0	0	0	0	0	0	0	0	0

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
all	0	0	0	0	0	0	0	0	0	0

units:	NA	NA								
Slot	discards.n:									
An	object	of	class	FLQuant						
	unit	=	unique	season	=	all	area	=	unique	

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0

units:	NA									
Slot	discards.wt:									
An	object	of	class	FLQuant						
	unit	=	unique	season	=	all	area	=	unique	

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0

units:	NA								
Slot	landings:								
An	object	of	class	FLQuant					
	unit	=	unique	season	=	all	area	=	unique

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
all	8091.3	6609.3	10093.6	7076.8	8337.5	7765	8557.4	3917.9	7734.2	6212.3

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
all	5460.8	2299.7	4948.9	7380.2	7541.4	6617.1	10174	6780.3	5748.7	7647.9

units:	NA	*	NA						
Slot	landings.n:								
An	object	of	class	FLQuant					
	unit	=	unique	season	=	all	area	=	unique

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	1.17E+05	5.05E+04	3.10E+05	2.46E+05	2.19E+05	2.03E+05	2.03E+05	9.84E+04	7.40E+04	8.44E+04
3	1.13E+05	8.69E+04	6.15E+04	5.31E+04	4.98E+04	4.53E+04	4.42E+04	2.96E+04	3.96E+04	3.25E+04
4	2.09E+04	1.73E+04	1.72E+04	1.24E+03	2.53E+04	2.34E+04	2.31E+04	6.43E+03	3.65E+04	2.60E+04
5	3.29E+02	9.74E+03	1.76E+03	7.92E+00	2.84E+03	3.41E+03	4.39E+03	2.82E+03	1.75E+04	1.79E+04
6	3.27E+00	1.83E+03	9.23E+02	3.31E+00	6.66E+01	6.75E+01	3.48E+03	1.21E+03	5.61E+03	2.28E+03

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	1.44E+05	1.63E+04	1.54E+05	1.88E+05	1.90E+05	1.93E+05	3.01E+05	2.09E+05	1.64E+05	2.60E+05
3	4.49E+04	3.84E+04	1.76E+04	3.69E+04	3.68E+04	6.04E+04	9.57E+04	8.59E+04	6.34E+04	1.42E+05
4	1.04E+04	6.10E+03	1.05E+04	1.47E+04	2.67E+04	1.38E+04	2.06E+04	1.22E+04	8.20E+03	1.28E+04
5	1.20E+03	1.52E+03	6.09E+03	1.10E+04	8.00E+03	1.63E+03	3.75E+03	6.48E+03	5.13E+03	4.62E+03
6	2.30E+00	2.61E+02	3.03E+02	2.97E+03	7.82E+02	1.84E+00	1.80E+00	2.11E+00	7.38E+02	4.74E+02

units:	NA								
Slot	landings.wt:								
An	object	of	class	FLQuant					
	unit	=	unique	season	=	all	area	=	unique

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0.020382	0.020382	0.020382	0.02038	0.020382	0.020382	0.021875	0.020582	0.023215	0.02097
3	0.037392	0.037392	0.037392	0.03739	0.037392	0.037392	0.03944	0.037032	0.038541	0.03817
4	0.069215	0.069215	0.069215	0.06922	0.069215	0.069215	0.068103	0.0651	0.061075	0.05616
5	0.089646	0.089646	0.089646	0.08965	0.089646	0.089646	0.086428	0.081952	0.083937	0.08195
6	0.123577	0.142178	0.142156	0.12358	0.141582	0.141589	0.122144	0.122146	0.142193	0.12215

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	0.021096	0.019833	0.0204	0.02034	0.02043	0.019057	0.018603	0.016111	0.017116	0.01352
3	0.038728	0.03833	0.036835	0.03822	0.035574	0.033669	0.032816	0.028788	0.032731	0.02404
4	0.055832	0.057436	0.059149	0.05807	0.060426	0.056435	0.05531	0.043051	0.052603	0.03895

5	0.081952	0.080134	0.081952	0.08239	0.081707	0.078748	0.080323	0.0639	0.076084	0.04284
6	0.121981	0.119765	0.122154	0.12853	0.118179	0.109729	0.123577	0.123577	0.070717	0.06267
units:	NA									
Slot	stock:									
An	object	of	class	FLQuant						
	unit	=	unique	season	=	all	area	=	unique	
age/year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
all	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
age/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
all	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
units:	NA	*	NA							
Slot	stock.n:									
An	object	of	class	FLQuant						
	unit	=	unique	season	=	all	area	=	unique	
age/year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2	2.46E+05	1.32E+05	4.28E+05	3.56E+05	3.27E+05	3.12E+05	3.21E+05	1.85E+05	1.34E+05	1.70E+05
3	1.38E+05	1.09E+05	6.94E+04	8.86E+04	8.54E+04	8.50E+04	8.59E+04	9.44E+04	7.15E+04	4.91E+04
4	3.33E+04	1.96E+04	1.76E+04	5.36E+03	3.14E+04	3.16E+04	3.55E+04	3.75E+04	5.95E+04	2.85E+04
5	4.36E+02	1.14E+04	1.81E+03	1.74E+01	3.90E+03	5.18E+03	7.37E+03	1.13E+04	2.95E+04	2.11E+04
6	4.32E+00	2.12E+03	9.37E+02	7.26E+00	9.14E+01	1.02E+02	5.83E+03	4.84E+03	9.44E+03	2.68E+03
age/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2	2.35E+05	6.83E+04	2.42E+05	2.65E+05	3.07E+05	3.40E+05	4.37E+05	3.16E+05	4.04E+05	3.89E+05
3	7.18E+04	7.34E+04	4.54E+04	7.03E+04	5.89E+04	9.48E+04	1.21E+05	1.05E+05	8.45E+04	2.06E+05
4	1.45E+04	2.36E+04	3.13E+04	2.54E+04	2.99E+04	1.93E+04	3.01E+04	2.02E+04	1.50E+04	1.76E+04
5	1.76E+03	3.69E+03	1.66E+04	1.96E+04	9.85E+03	2.50E+03	4.94E+03	8.64E+03	7.34E+03	6.30E+03
6	3.36E+00	6.30E+02	8.24E+02	5.29E+03	9.59E+02	2.81E+00	2.36E+00	2.80E+00	1.05E+03	6.43E+02
units:	NA									
Slot	stock.wt:									
An	object	of	class	FLQuant						
	unit	=	unique	season	=	all	area	=	unique	
age/year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2	0.020382	0.020382	0.020382	0.02038	0.020382	0.020382	0.021875	0.020582	0.023215	0.02097
3	0.037392	0.037392	0.037392	0.03739	0.037392	0.037392	0.03944	0.037032	0.038541	0.03817
4	0.069215	0.069215	0.069215	0.06922	0.069215	0.069215	0.068103	0.0651	0.061075	0.05616
5	0.089646	0.089646	0.089646	0.08965	0.089646	0.089646	0.086428	0.081952	0.083937	0.08195
6	0.123577	0.142178	0.142156	0.12358	0.141582	0.141589	0.122144	0.122146	0.142193	0.12215
age/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**

2	0.021096	0.019833	0.0204	0.02034	0.02043	0.019057	0.018603	0.016111	0.017116	0.01352
3	0.038728	0.03833	0.036835	0.03822	0.035574	0.033669	0.032816	0.028788	0.032731	0.02404
4	0.055832	0.057436	0.059149	0.05807	0.060426	0.056435	0.05531	0.043051	0.052603	0.03895
5	0.081952	0.080134	0.081952	0.08239	0.081707	0.078748	0.080323	0.0639	0.076084	0.04284
6	0.121981	0.119765	0.122154	0.12853	0.118179	0.109729	0.123577	0.123577	0.070717	0.06267

units: NA

Slot m:

An object of class FLQuant

unit = unique season = all area = unique

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0.1163	0.1163	0.1163	0.1163	0.1163	0.1163	0.1163	0.1163	0.1163	0.1163
3	0.0697	0.0697	0.0697	0.0697	0.0697	0.0697	0.0697	0.0697	0.0697	0.0697
4	0.0464	0.0464	0.0464	0.0464	0.0464	0.0464	0.0464	0.0464	0.0464	0.0464
5	0.0324	0.0324	0.0324	0.0324	0.0324	0.0324	0.0324	0.0324	0.0324	0.0324
6	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	0.1163	0.1163	0.1163	0.1163	0.1163	0.1163	0.1163	0.1163	0.1163	0.1163
3	0.0697	0.0697	0.0697	0.0697	0.0697	0.0697	0.0697	0.0697	0.0697	0.0697
4	0.0464	0.0464	0.0464	0.0464	0.0464	0.0464	0.0464	0.0464	0.0464	0.0464
5	0.0324	0.0324	0.0324	0.0324	0.0324	0.0324	0.0324	0.0324	0.0324	0.0324
6	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023

units: NA

Slot mat:

An object of class FLQuant

unit = unique season = all area = unique

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	1	1	1	1	1	1	1	1	0.9	0.9
3	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1

units: NA

Slot harvest:

An object of class FLQuant

	unit	=	unique	season	=	all	area	=	unique	

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0.69954	0.52279	1.45839	1.31151	1.23252	1.17238	1.10749	0.83234	0.88386	0.74661
3	1.88412	1.75031	2.49124	0.96898	0.9242	0.80337	0.75972	0.39204	0.85134	1.15301
4	1.02765	2.33718	6.87481	0.27095	1.75475	1.4105	1.09976	0.19296	0.9877	2.7401
5	1.45883	2.04828	4.69254	0.62075	1.3421	1.10892	0.93127	0.29271	0.92102	1.95083
6	1.45883	2.04828	4.69254	0.62075	1.3421	1.10892	0.93127	0.29271	0.92102	1.95083

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	1.04949	0.29179	1.12101	1.38962	1.06022	0.91875	1.3083	1.20349	0.56001	1.22529
3	1.04297	0.78133	0.51286	0.78485	1.04329	1.07671	1.71864	1.87757	1.49994	1.25667
4	1.32051	0.30707	0.4207	0.89963	2.43617	1.31891	1.20227	0.96551	0.82082	1.35547
5	1.18393	0.54483	0.46727	0.84354	1.74345	1.08733	1.47677	1.43654	1.23974	1.37255
6	1.18393	0.54483	0.46727	0.84354	1.74345	1.08733	1.47677	1.43654	1.23974	1.37255

units:	f									
Slot	harvest.spwn:									
An	object	of	class	FLQuant						
	unit	=	unique	season	=	all	area	=	unique	

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0

units:	NA									
Slot	m.spwn:									
An	object	of	class	FLQuant						
	unit	=	unique	season	=	all	area	=	unique	

age/year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
units:	NA									
Slot	name:									
[1]	BLACK SEA WHITING,2014,COMBSEX,PLUSGROUP,INDEX FILE									
Slot	desc:									
[1]	Imported from a VPA file. (BSW_94_2013IND.DAT). Thu Oct 09 19:05:34 2014 + FLAssess:									
Slot	range:									
	min	max	plusgroup	minyear	maxyear	minfbar	maxfbar			
	2	6	6	1994	2013	2	4			

>	bsw.idx						
An	object	of	class	FLIndices			
[[1]]							
An	object	of	class	FLIndex			
Slot	type:						
[1]	numbers						
Slot	distribution:						
character(0)							
Slot	index:						
An	object	of	class	FLQuant			
	unit=	unique	season=	all	area=	=	unique
age/year	2007	2008	2009	2010	2011	2012	2013
2	449264	401439	286875	483517	791570	252230	1E+06
3	66062	41103	65124	51510	72781	33361	240506
4	NA	NA	18169	29579	16149	NA	57814
units:	NA						
Slot	index.var:						
An	object	of	class	FLQuant			
	unit=	unique	season=	all	area=	=	unique
age/year	2007	2008	2009	2010	2011	2012	2013
2	NA	NA	NA	NA	NA	NA	NA
3	NA	NA	NA	NA	NA	NA	NA

4	NA	NA	NA	NA	NA	NA	NA
units:	NA						
Slot	catch.n:						
An	object	of	class	FLQuant			
	unit=	unique	season=	all	area=	=	unique
age/year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2	449264	401439	286875	483517	791570	252230	1E+06
3	66062	41103	65124	51510	72781	33361	240506
4	NA	NA	18169	29579	16149	NA	57814
units:	NA						
Slot	catch.wt:						
An	object	of	class	FLQuant			
	unit=	unique	season=	all	area=	=	unique
age/year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2	NA	NA	NA	NA	NA	NA	NA
3	NA	NA	NA	NA	NA	NA	NA
4	NA	NA	NA	NA	NA	NA	NA
units:	NA						
Slot	effort:						
An	object	of	class	FLQuant			
	unit=	unique	season=	all	area=	=	unique
age	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
all	1	1	1	1	1	1	1
units:	NA						
Slot	sel.pattern:						
An	object	of	class	FLQuant			
unit=	unique	season	=	all	area	=	unique
age/year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2	NA	NA	NA	NA	NA	NA	NA
3	NA	NA	NA	NA	NA	NA	NA
4	NA	NA	NA	NA	NA	NA	NA
units:	NA						
Slot	index.q:						
An	object	of	class	FLQuant			
unit=	unique	season	=	all	area	=	unique

age/year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	
2	NA	NA	NA	NA	NA	NA	NA	
3	NA	NA	NA	NA	NA	NA	NA	
4	NA	NA	NA	NA	NA	NA	NA	
units:	NA							
Slot	name:							
[1]	RO Trawl fleet							
Slot	desc:							
[1]	BLACK SEA Whiting Total,2014,COMBSEX,TUNING DATA							
	(survey, nos at age,4 group is plus group, thousands) . Imported from VPA file.							
Slot	range:							
	min	max	plusgroup	minyear	maxyear	startf	endf	
	2	4	4	2007	2013	0.4	0.5	
[[2]]								
An	object	of	class	FLIndex				
Slot	type:							
[1]	numbers							
Slot	distribution:							
character(0)								
Slot	index:							
An	object	of	class	FLQuant				
	unit=	unique	season	=	all	area	=	unique
age/year	**2009**	**2010**	**2011**	**2012**	**2013**			
2	7406.6	2383.7	1889.7	1208.988	1740.3271			
3	2322.4	758.1	780.3	470.1365	953.3966			
4	533.5	162.9	110.7	60.4265	85.6225			
5	62.8	28.7	58.9	37.9954	31.063			
6	NA	NA	NA	5.4933	3.186			
units:	NA							
Slot	index.var:							
An	object	of	class	FLQuant				
	unit=	unique	season=	all	area=	unique		
	year							
age/year	**2009**	**2010**	**2011**	**2012**	**2013**			
2	NA	NA	NA	NA	NA			

3	NA	NA	NA	NA	NA	
4	NA	NA	NA	NA	NA	
5	NA	NA	NA	NA	NA	
6	NA	NA	NA	NA	NA	
units:	NA					
Slot	catch.n:					
An	object	of	class	FLQuant		
	unit=	unique	season=	all	area=	unique
age/year	**2009**	**2010**	**2011**	**2012**	**2013**	
2	7406.6	2383.7	1889.7	1208.988	1740.3271	
3	2322.4	758.1	780.3	470.1365	953.3966	
4	533.5	162.9	110.7	60.4265	85.6225	
5	62.8	28.7	58.9	37.9954	31.063	
6	NA	NA	NA	5.4933	3.186	
units:	NA					
Slot	catch.wt:					
An	object	of	class	FLQuant		
	unit=	unique	season=	all	area=	unique
age/year	**2009**	**2010**	**2011**	**2012**	**2013**	
2	NA	NA	NA	NA	NA	
3	NA	NA	NA	NA	NA	
4	NA	NA	NA	NA	NA	
5	NA	NA	NA	NA	NA	
6	NA	NA	NA	NA	NA	
units:	NA					
Slot	effort:					
An	object	of	class	FLQuant		
	unit=	unique	season=	all	area=	unique
age	**2009**	**2010**	**2011**	**2012**	**2013**	
all	1	1	1	1	1	
units:	NA					
Slot	sel.pattern:					
An	object	of	class	FLQuant		
	unit=	unique	season=	all	area=	unique

age/year	**2009**	**2010**	**2011**	**2012**	**2013**		
2	NA	NA	NA	NA	NA		
3	NA	NA	NA	NA	NA		
4	NA	NA	NA	NA	NA		
5	NA	NA	NA	NA	NA		
6	NA	NA	NA	NA	NA		
units:	NA						
Slot	index.q:						
An	object	of	class	FLQuant			
	unit=	unique	season=	all	area=	unique	
age/year	**2009**	**2010**	**2011**	**2012**	**2013**		
2	NA	NA	NA	NA	NA		
3	NA	NA	NA	NA	NA		
4	NA	NA	NA	NA	NA		
5	NA	NA	NA	NA	NA		
6	NA	NA	NA	NA	NA		
units:	NA						
Slot	name:						
[1]	TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)						
Slot	desc:						
[1]	BLACK SEA Whiting Total,2014,COMBSEX,TUNING DATA						
	(survey, nos at age,4 group is plus group, thousands) . Imported from VPA file.						
Slot	range:						
	min	max	plusgroup	minyear	maxyear	startf	endf
	2	6	6	2009	2013	0.4	0.5
Slot	names:						
[1]	RO Trawl fleet						
[2]	TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)						
Slot	desc:						
character(0)							
Slot	lock:						
[1]	FALSE						

6.3.4.4 Results

The STECF EWG 14 14 applied the Extended Survivors Analysis (XSA, Shepherd, 1992) and the technique “shrinkage to the mean” for assessing the stock of whiting in 1994-2013.

The tuning of XSA is defined according to the default settings of the program. Catchability is set dependent on stock size for ages >2 and independent of age for ages >3. The Turkish CPUE survey data gets the majority of the weight for the calculation of the survivors at all ages except age 3 and the corresponding fishing mortality. This is confirmed from the tuning diagnostics, presented on Tab. 6.3.4.4.1.

Multiple XSA runs were done using different shrinkage options. The best model fit was chosen in order to downweight trends in catchability residuals. The estimated SSB, recruitment and fishing mortality under different shrinkage options are given on Fig. 6.3.4.4.1, Fig. 6.3.4.4.2 and Fig. 6.3.4.4.3.

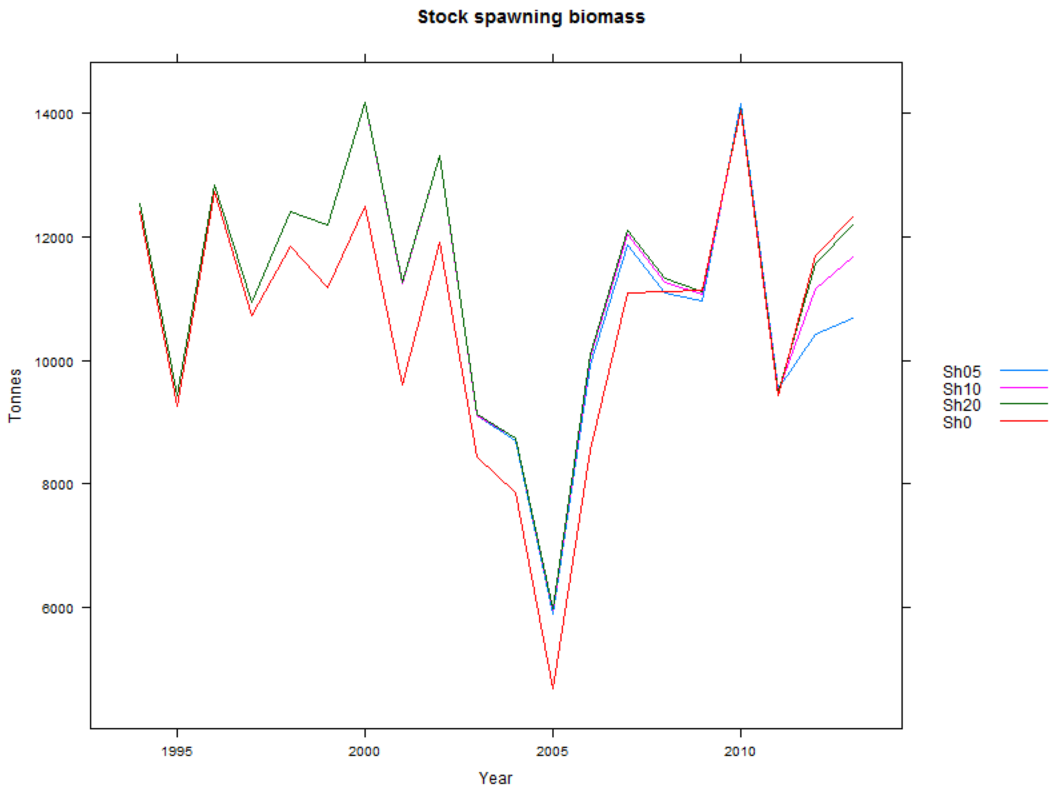


Fig. 6.3.4.4.1. Sensitivity analysis on Spawning Stock Biomass for different levels of shrinkage.

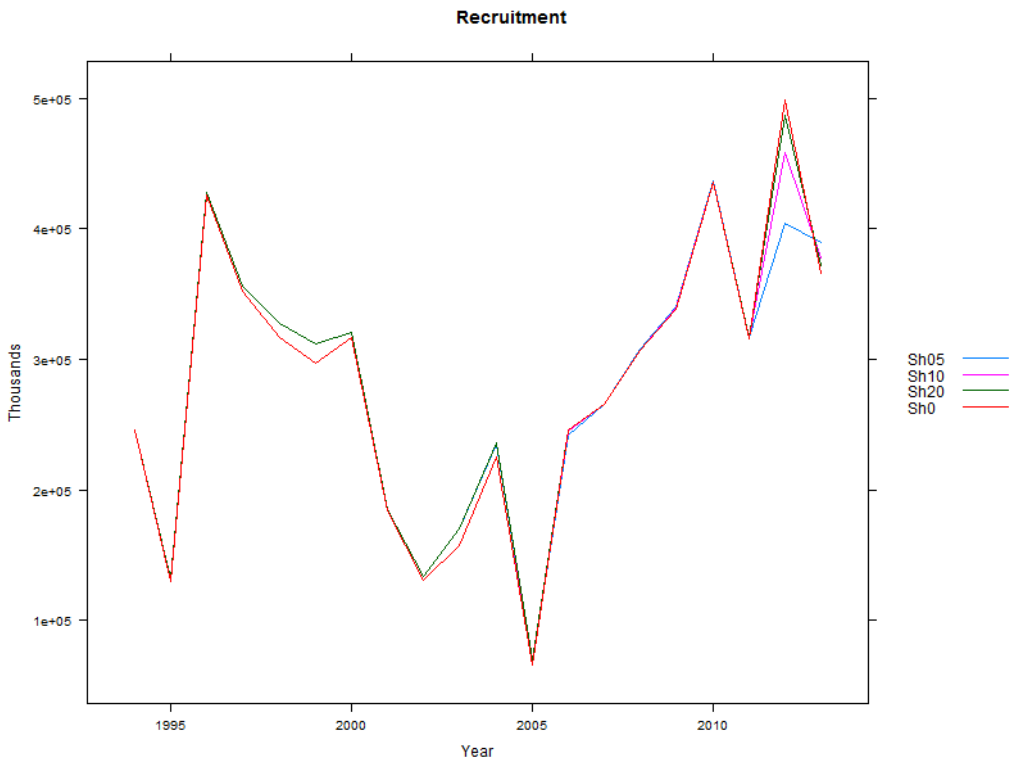


Fig. 6.3.4.4.2. Sensitivity analysis on Recruitment for different levels of shrinkage. In this assessment Recruitment is estimated on age 2, so it is not representative of younger age classes.

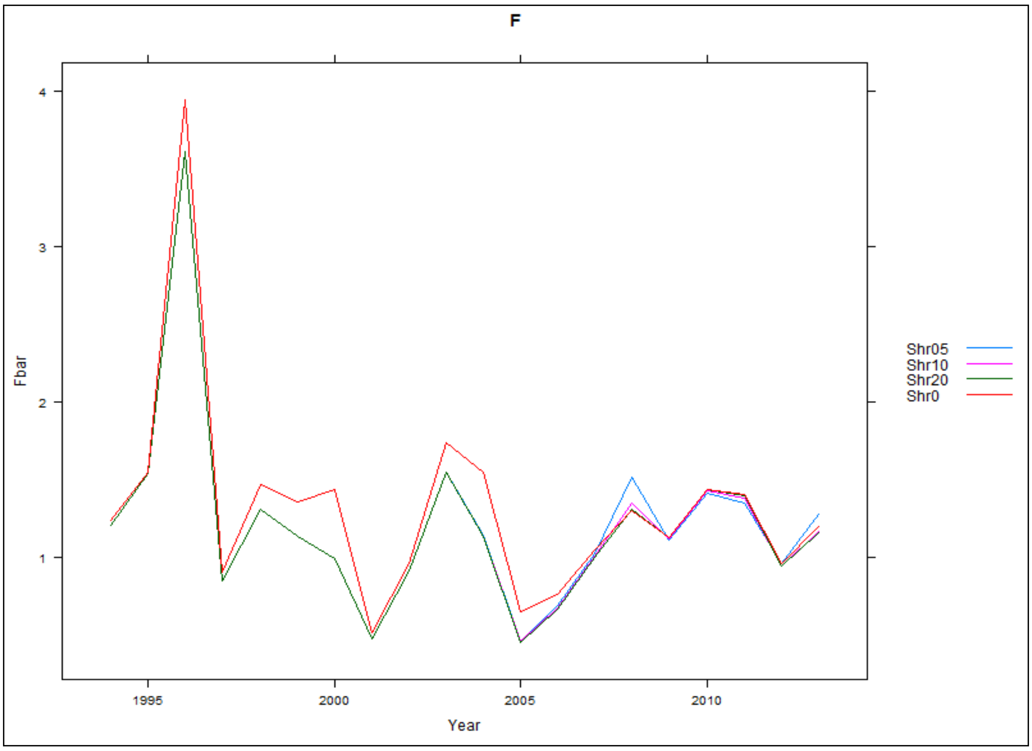


Fig. 6.3.4.4.3. Sensitivity analysis on Fbar(2-4) for different levels of shrinkage

The residuals of log transformed catchability are plotted for each tuning index and shrinkage level in Fig. 6.3.4.4.4 - 6.3.4.4.7.

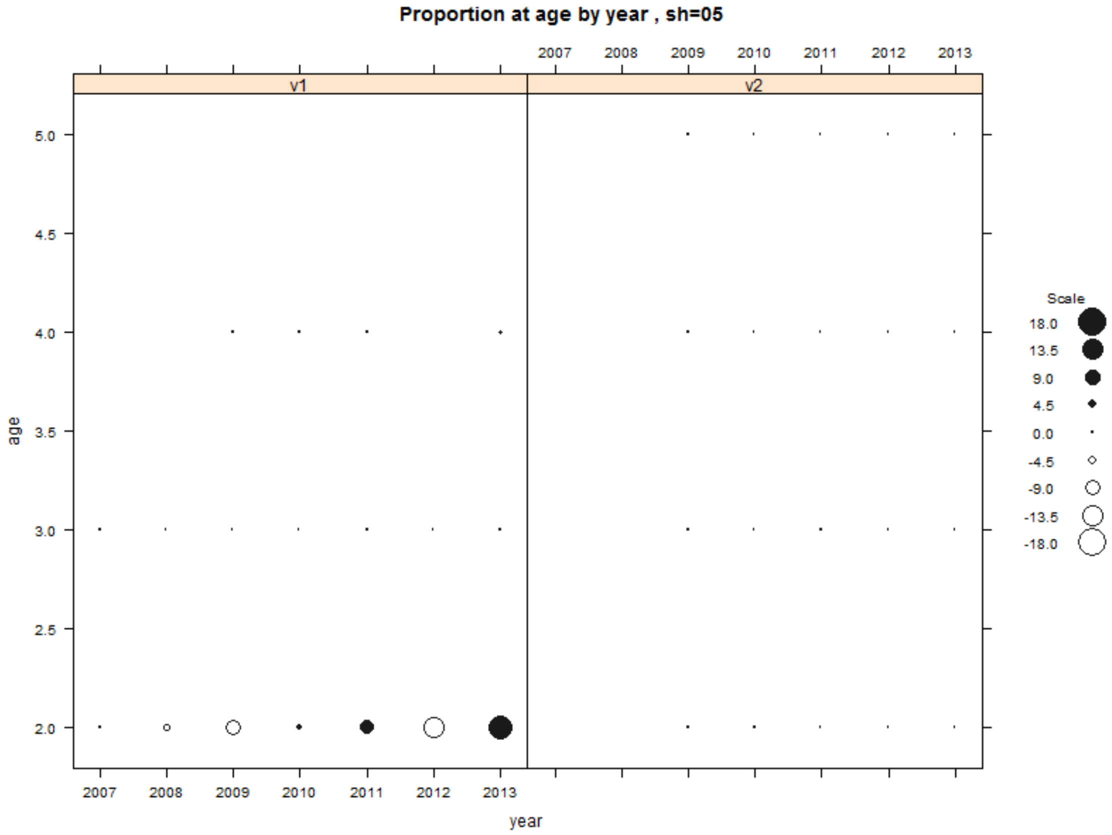


Fig 6.3.4.4.4. Residuals of log transformed catchability applying a very low shrinkage of 0.5. V1=Romanian tuning index, V2=Turkish tuning index.

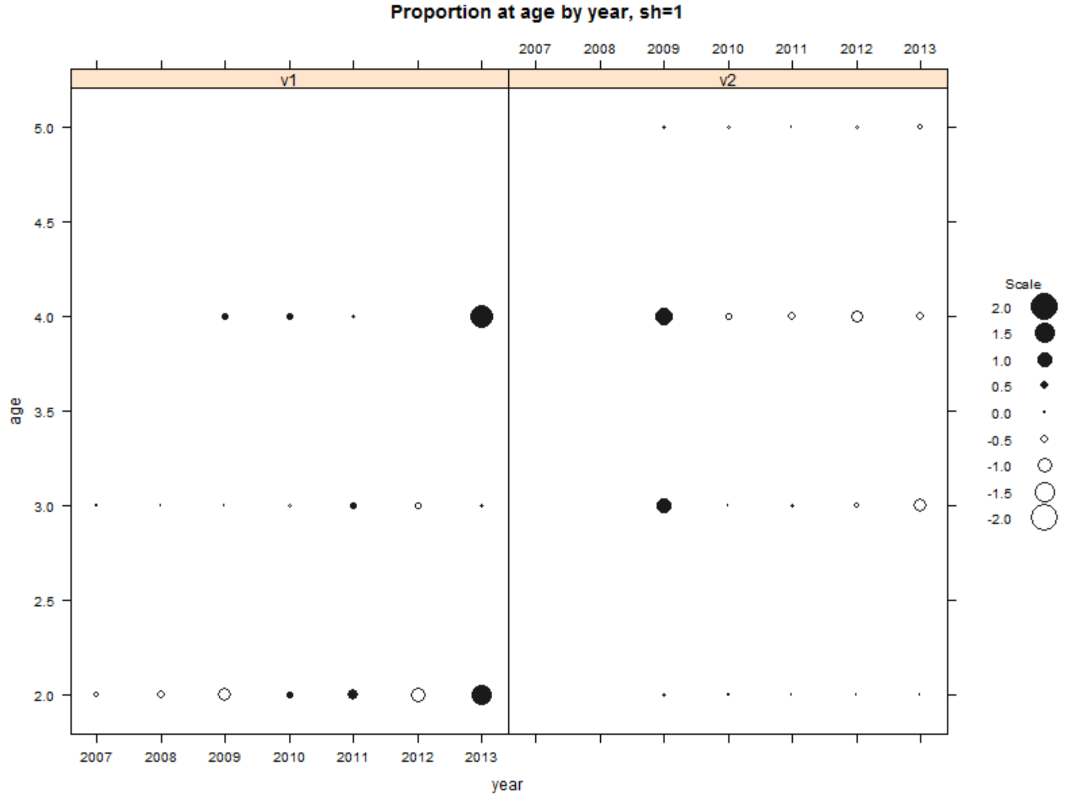


Fig 6.3.4.4.5. Residuals of log transformed catchability applying a very low shrinkage of 1.0. V1=Romanian tuning index, V2=Turkish tuning index.

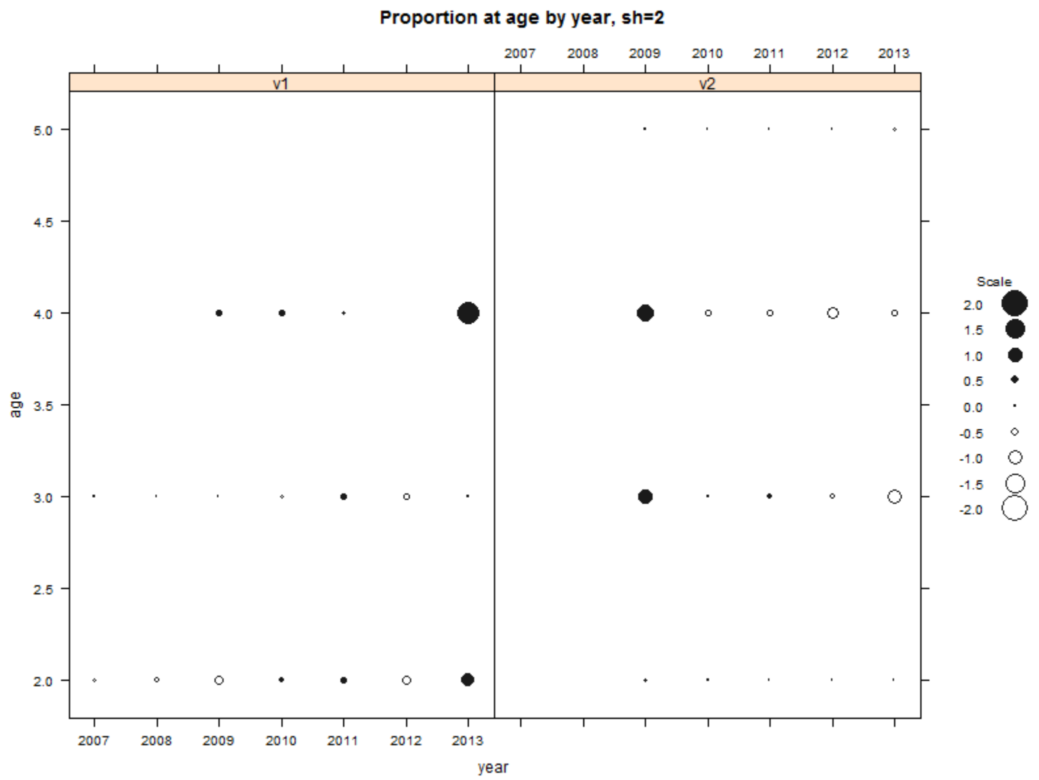


Fig 6.3.4.4.6. Residuals of log transformed catchability applying a very low shrinkage of 2.0. V1=Romanian tuning index, V2=Turkish tuning index.

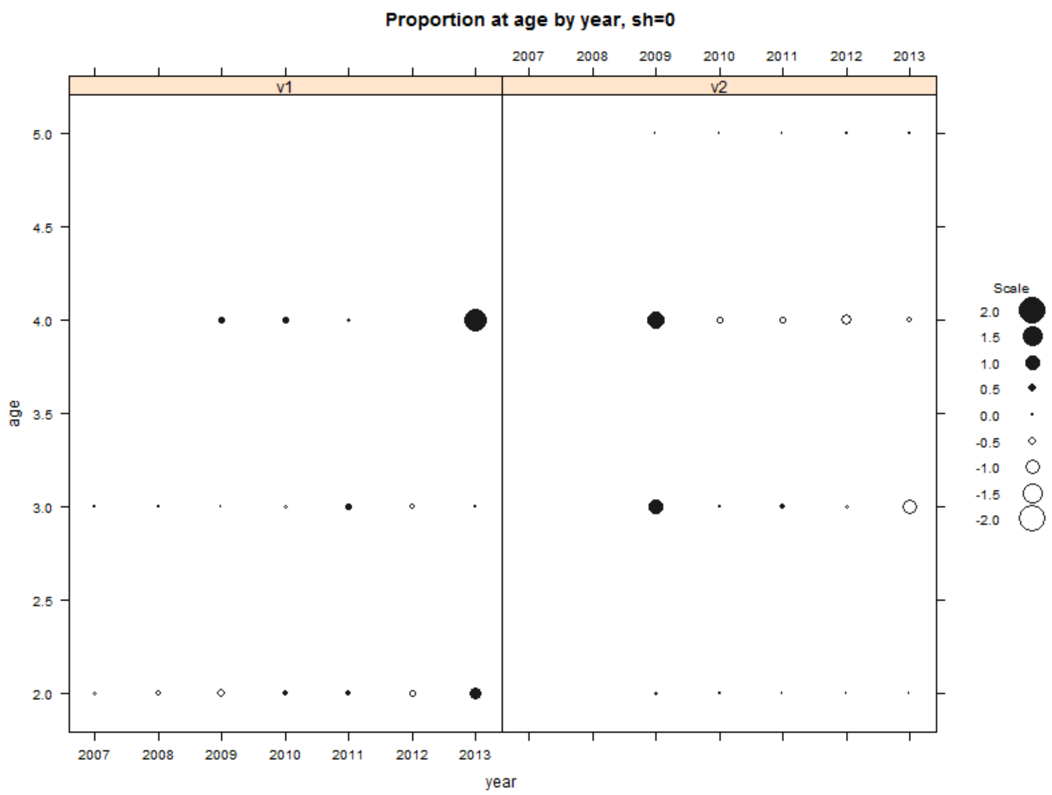


Fig 6.3.4.4.7. Residuals of log transformed catchability applying a very low shrinkage of 0 V1=Romanian tuning index, V2=Turkish tuning index.

Retrospective behaviour of the fishing mortality (average over ages 2-4), SSB and recruitment for different assessment runs are presented on Fig. 6.3.4.4.8 - 6.3.4.4.10.

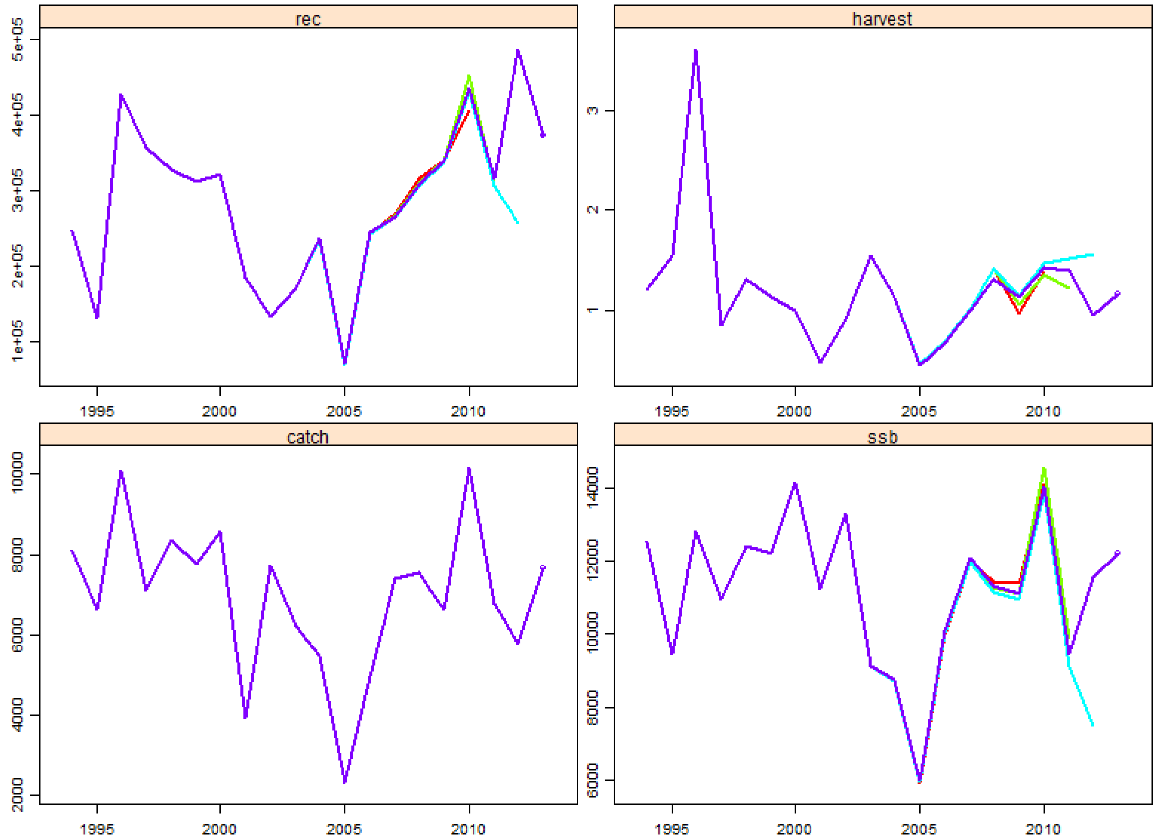


Fig. 6.3.4.4.8. . XSA retrospective patterns for last 3 years with shrinkage (0.5). F is averaged over ages 2-4.

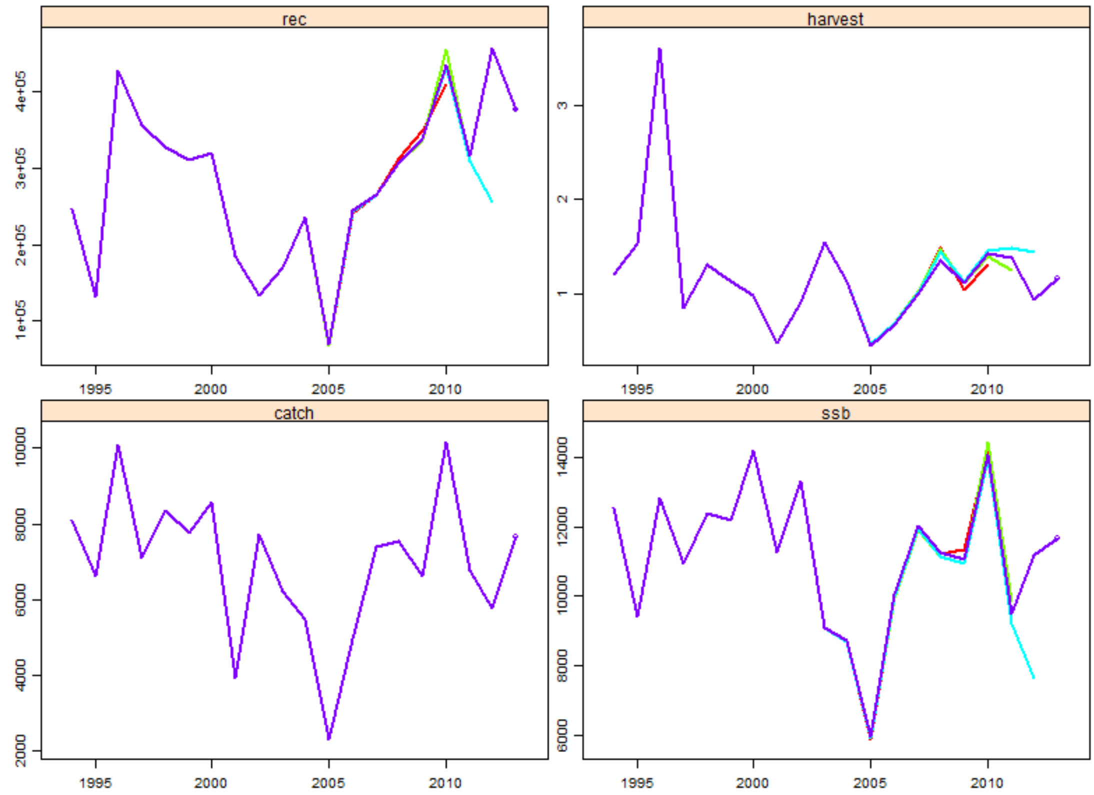


Fig. 6.3.4.4.9. XSA retrospective patterns for last 3 years with shrinkage (1). F is averaged over ages 2-4.

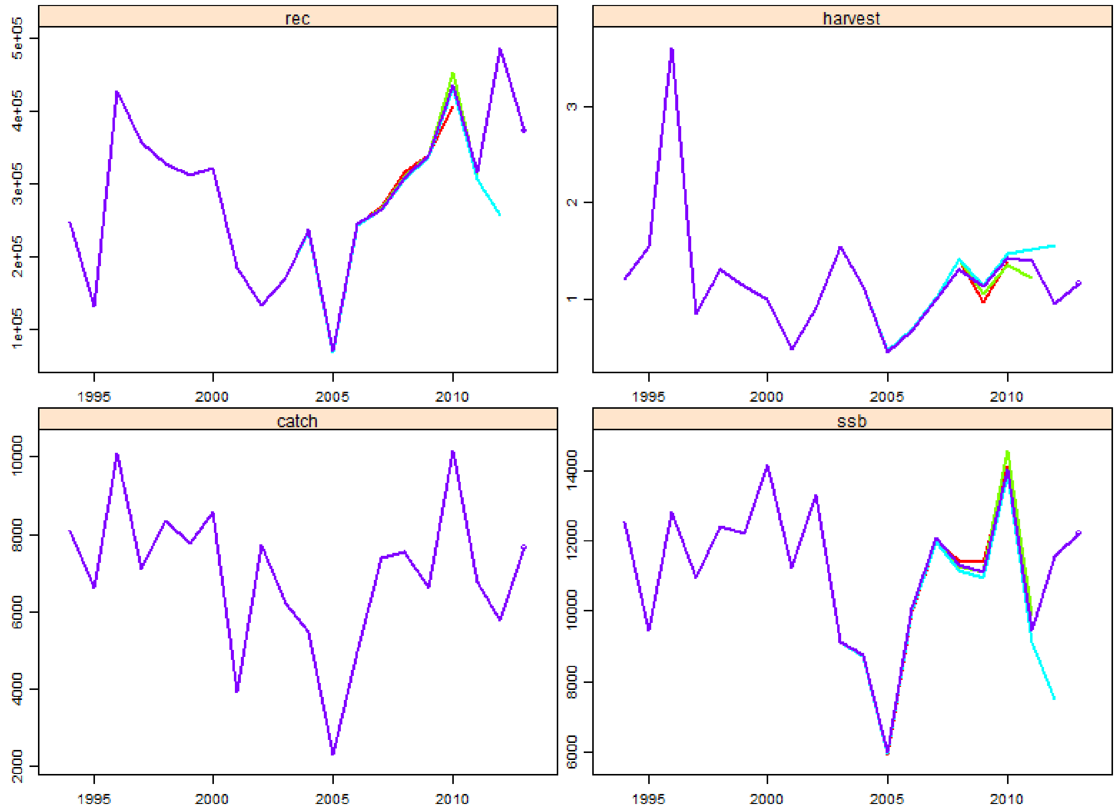


Fig. 6.3.4.4.10. XSA retrospective patterns for last 3 years with shrinkage (2). F is averaged over ages 2-4.

Overall the best model in terms of residual plots and retrospective patters is the model with shrinkage of 2 and this XSA run is the retained one (Fig. 6.3.4.4.10). A zoom in on the mean F for ages 2-4 is plotted in (Fig. 6.3.4.4.12).

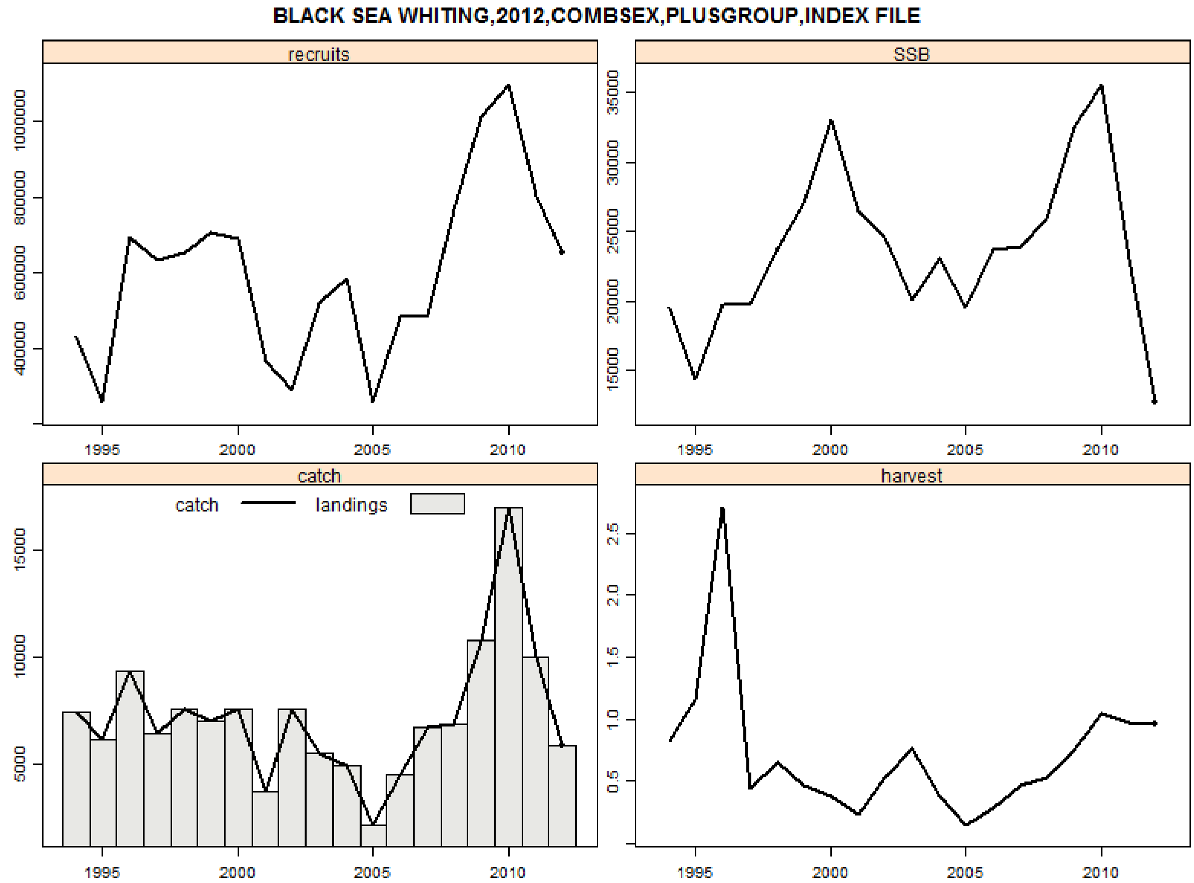


Fig. 6.3.4.4.11. Best final XSA assessment with shrinkage=2. F is averaged over ages 2-4.

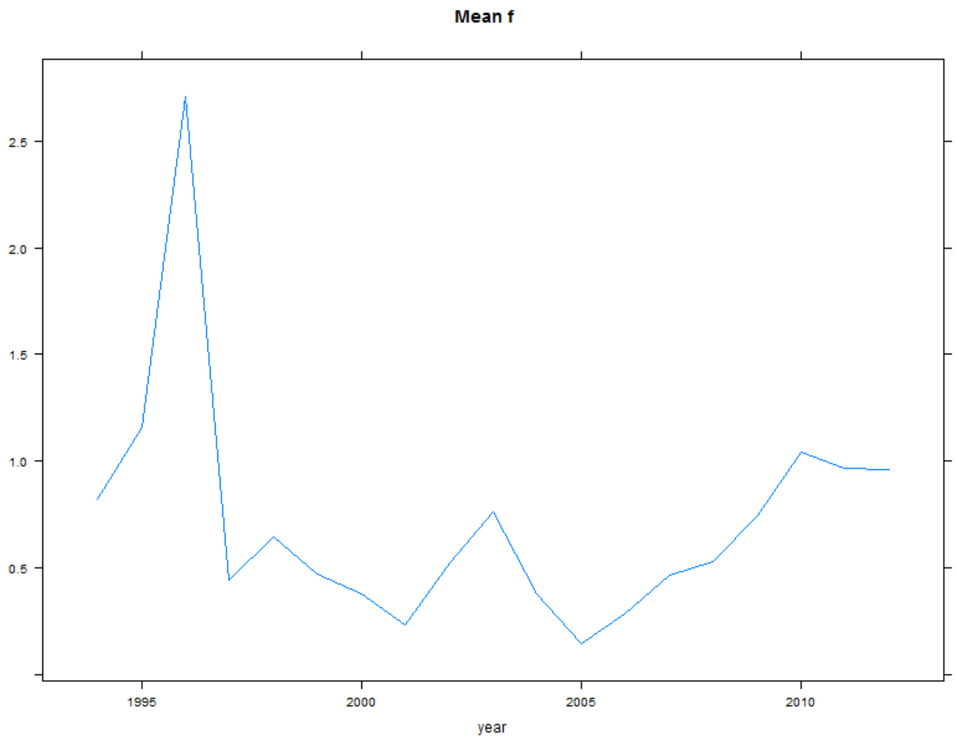


Fig. 6.3.4.4.12. Mean F for ages 2-4 for Whiting in the Black Sea estimate in XSA run with shrinkage of 2.

Table 6.3.4.4.1 XSA outputs and diagnostics

Year	ssb	fbar	rec	catch	
1994	12530.63292	1.203768964	246209.9189	8091.319376	8091.319
1995	9429.760461	1.536761745	131558.8857	6609.302556	6609.303
1996	12831.69047	3.608146802	427784.9668	10093.64258	10093.64
1997	10946.18342	0.850478943	356215.2825	7076.787146	7076.787
1998	12399.04766	1.303808313	327333.3923	8337.537365	8337.537
1999	12198.13449	1.128713638	311755.3244	7765.025926	7765.026
2000	14175.29605	0.988906836	320932.4674	8557.378829	8557.379
2001	11253.44013	0.472389911	184690.7488	3917.895033	3917.895
2002	13312.86942	0.907245779	133628.5203	7734.161908	7734.162
2003	9116.282403	1.543370799	170599.4327	6212.313964	6212.314
2004	8737.2459	1.128553401	236335.6653	5460.79546	5460.795
2005	5972.79943	0.452118093	69371.85136	2299.690504	2299.691
2006	10105.40199	0.667255931	245512.2282	4948.863405	4948.863
2007	12098.71243	0.994987166	265149.3658	7380.169079	7380.169
2008	11326.39025	1.308548447	307190.1064	7541.389638	7541.39
2009	11117.94187	1.121670081	338778.6658	6617.135566	6617.136
2010	14062.51767	1.432329549	435737.2429	10173.96838	10173.97
2011	9460.488794	1.394377247	316279.2552	6780.263142	6780.263
2012	11561.92271	0.943137969	486960.2741	5748.665984	5748.666
2013	12201.40728	1.153769623	372275.7647	7647.933546	7647.934

Diagnostics for the best XSA run are detailed below:

```
FLR XSA Diagnostics 2014-10-24 10:52:02

CPUE data from indices

Catch data for 20 years 1994 to 2013. Ages 2 to 6.

                                                          fleet first age
last age first year last year alpha
1                                                RO Trawl fleet         2
4       2007      2013  <NA>
2 TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)         2
5       2009      2013  <NA>
  beta
1 <NA>
2 <NA>


 Time series weights :

    Tapered time weighting applied
   Power =   3 over  20 years

 Catchability analysis :

     Catchability independent of size for ages >   2

     Catchability independent of age for ages >   3

 Terminal population estimation :

     Survivor estimates shrunk towards the mean F
    of the final   5 years or the  2 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   2

    Minimum standard error for population
    estimates derived from each fleet =  0.3

    prior weighting not applied

Regression weights
     year
age    2004 2005  2006  2007  2008  2009 2010  2011 2012 2013
  all 0.751 0.82 0.877 0.921 0.954 0.976 0.99 0.997    1    1


 Fishing mortalities
   year
age  2004  2005  2006  2007  2008  2009  2010  2011  2012  2013
  2 1.042 0.287 1.094 1.393 1.062 0.924 1.314 1.204 0.440 1.343
  3 1.033 0.768 0.500 0.739 1.053 1.082 1.763 1.918 1.504 0.748
  4 1.311 0.301 0.408 0.853 1.811 1.359 1.220 1.060 0.886 1.370
  5 1.174 0.535 0.454 0.797 1.435 0.393 1.685 1.523 1.741 1.807
  6 1.174 0.535 0.454 0.797 1.435 0.393 1.685 1.523 1.741 1.807


 XSA population number (Thousand)
      age
year        2      3     4     5    6
  2004 236336  72199 14516  1763    3
  2005  69372  74195 23979  3736  638
  2006 245512  46359 32096 16937  842
  2007 265149  73201 26234 20370 5489
```

```
  2008 307190  58594 32622 10672 1039
  2009 338779  94563 19076  5090    6
  2010 435737 119651 29900  4680    2
  2011 316279 104290 19136  8426    3
  2012 486960  84439 14282  6327  906
  2013 372276 279224 17503  5624  574


 Estimated population abundance at 1st Jan  2014
      age
year   2     3      4    5   6
  2014 1 86497 123303 4244 894


 Fleet:  RO Trawl fleet

 Log catchability residuals.

   year
age   2007   2008   2009   2010  2011   2012  2013
  2 -0.218 -0.332 -0.632  0.316 0.439 -0.615 1.000
  3  0.110 -0.001 -0.007 -0.171 0.382 -0.373 0.067
  4     NA     NA  0.432  0.407 0.177     NA 1.680

 Regression statistics
 Ages with q dependent on year class strength
[1] "-0.99959907051582" "26.3947979171688"


 Fleet:  TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)

 Log catchability residuals.

   year
age  2009   2010   2011   2012   2013
  2 0.135  0.075 -0.105 -0.061 -0.041
  3 1.061  0.012  0.248 -0.233 -1.062
  4 1.305 -0.393 -0.405 -0.796 -0.433
  5 0.047 -0.072 -0.014 -0.068 -0.122

 Regression statistics
 Ages with q dependent on year class strength
[1] "-0.412188380821384" "16.2722935231156"


 Terminal year survivor and F summaries:

 ,Age 2 Year class =2011

source
                                                                     scaledWts su
rvivors yrcls
RO Trawl fleet                                                           0.046
31806  2011
TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)     0.336
95486  2011
fshk                                                                     0.031
143643  2011
nshk                                                                     0.587
86132  2011

 ,Age 3 Year class =2010

source
```

```
                                                                  scaledWts su
rvivors yrcls
RO Trawl fleet                                                        0.852
131859  2010
TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)         0.108
42636  2010
fshk                                                                  0.040
40917  2010

 ,Age 4 Year class =2009

source
                                                                  scaledWts su
rvivors yrcls
RO Trawl fleet                                                        0.255
22782  2009
TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)         0.406
2752  2009
fshk                                                                  0.339
4863  2009

 ,Age 5 Year class =2008

source
                                                                  scaledWts su
rvivors yrcls
TR Trawl fleet (6 is a plusgroup, CPUE, nos at age,thousands)         0.879
791  2008
fshk
```

6.3.5 Short term prediction of stock biomass and catch

6.3.5.1 Justification

A deterministic short term projection of stock size and catch was not performed due to the uncertainty in the assessment originated by the poor quality of the discard data and the selection of age classes >1.

6.3.5.2 Input parameters

6.3.5.3 Results

6.3.6 Medium term prediction of stock biomass and catch

The EWG 14 14 did not undertake medium term projections.

6.3.7 Long term predictions

The EWG 14 14 did not undertake medium term projections.

6.3.8 Scientific advice

6.3.8.1 Short term considerations

6.3.8.2 Medium term considerations

6.4 MEDITERRANEAN HORSE MACKEREL IN GSA 29

6.4.1 Biological features

6.4.1.1 Stock identification

The Black sea horse mackerel is a subspecies of the Mediterranean horse mackerel *Trachurus mediterraneus.* Although in the past the Black sea horse mackerel has been attributed to various subpopulations, in a more recent study Prodanov *et al.* (1997) brought evidence that the horse mackerel rather exists as a single population in the Black sea, and thus all Black sea horse mackerel fished across the region should be treated as a unit stock.

The horse mackerel is a migratory species distributed in the whole Black Sea (Ivanov and Beverton, 1985, Fig. 6.4.1.1.1). In the spring it migrates to the north for reproduction and feeding. In summer the horse mackerel is distributed preferably in the shelf waters above the seasonal thermocline. In the autumn it migrates towards the withering grounds along the Anatolian and Caucasian coasts migration (Ivanov and Beverton, 1985). The horse mackerel population in the Black Sea mainly winters along the Crimean, Caucasian and Anatolian coasts and warm sections of the Marmara Sea. They winter at a depth ranging between 20 and 90 meters off Crimea and between 20 and 60 meters off the Caucasian coasts. The horse mackerel population continuously remains in the eastern Black Sea winters in an area north-east of Trabzon. The population migrating between Marmara and the eastern Black Sea spend the winter in the Bosphorus area and off the Marmara Sea at optimal depths ranging between 30 and 50 meters. Depending on water temperature, feeding migration starts in mid-April or towards the end of that month (Demir, 1958). Horse mackerel groups migrate from the Bosphorus to the Bulgarian and Romanian coasts in the north. They are also believed to migrate from Crimea to the north-west and from the Caucasian and north-eastern Anatolian coasts to the Crimean coasts. Autumn migration starts in September and reaches a peak in October and November (Ivanov and Beverton, 1985).

The family Carangidae is represented by two species in the Black Sea: *Trachurus trachurus* and *T. mediterraneus* (Drenski, 1948, 1951; Aleev, 1956; Georgiev and Kolarov, 1959, 1962; Stoyanov *et al.,* 1963; Svetovidov, 1964; Valkanov *et al.,* 1978; Sivkov, 2004; Zhivkov *et al.,* 2005; Kapapetkova and Zhivkov, 2006; Raykov and Yankova, 2008; Yankova *et al.,* 2010a; Yankova *et al*., 2014). The systematic position of the Black Sea horse mackerel was examined by Nümann (1956) and Aleev (1952, 1957). These authors stated that in the Black Sea the species is represented by four local subpopulations: a south western (Bosporic), a northern (Crimean), an eastern (Caucasian) and a southern (Anatolian). Each subpopulation has its own biological characteristics such as wintering grounds, fat content, spawning patterns, age composition, growth rate, feeding patterns.

According to some authors (Aleev, 1956; Georgiev and Kolarov, 1959, 1962; Stoyanov *et al.,* 1963; Kapapetkova and Zhivkov, 2006) the Black Sea horse mackerel is represented into two size-forms: ”large” and “small”. The presence of the large form has been reported for a first time in 1913 by S. A. Zernov (Aleev, 1956). However, after that time this form disappeared, but it is registered again in the territorial waters of Georgia in 1947 and is being intensively fished for 10 years. Draughts of the large form for the eastern part of the Black Sea reached up to 8601,7 t in 1954 (Tikhonov *et al.,* 1955). Since 1958, only single specimens are found in the nets (Dobrovolov, 2000). There are several hypotheses about the presence of the large horse mackerel in the Black Sea: a) it is a new immigrant from the Mediterranean (Aleev, 1956); b) it is the same small horse mackerel with accelerated growth under extremely favorable conditions (Tikhonov *et al.,* 1955; Shaverdov, 1964); c) it is an ecological breed that hibernates in the warmest areas (Aleev, 1957), or it is an ecotype (Shaverdov, 1964); d) it belongs to another species present in the Mediterranean or even in the Atlantic Ocean and in case of extremely high species numbers some shoals enter the Black Sea enlarging their nutritive territory (Altukhov and Salmenkova, 1981); e) it is a polyploid form of the small horse mackerel originating in the Black Sea (Georgiev and Kolarov, 1962); f) it is a "giant" horse mackerel as a new species *Trachurus gigas*, n.sp (Banarescu and Nalbant, 1979).

According to Shaverdov (1964), the "large" and "small" forms of the Black Sea horse mackerel belongs to one and the same subspecies as described by Aleev (1957). After the study of Golovko (1964) about the electrophoretic spectra of serum proteins from these two forms, Shulman and Kulikova (1966) reconsidered their own earlier assumption about the belonging of both forms to a taxonomically close but different species. Tkacheva (1957) performed crosses between small and large horse mackerel under field conditions on board a research motor boat, which showed the possibility to obtain hybrids. Until now, there does not exist any information confirming the polyploidity of the large form of horse mackerel. On the other hand, the existence of two different subspecies of *T. mediterraneus* in the Black Sea: *T. m.* ssp. *ponticus* and *T. m.* ssp. *mediterraneus* is described by Altukhov and Apekin (1963) based on serological analyses and also by Altukhov and Michalev (1964) by means of the characteristics of the cellular thermal (Prodanov *et al.,* 1997). According to Dobrovolov & Dobrovolova 1983; Dobrovolov and Manolov 1983; Dobrovolov, 1988 no difference at species level can be found between *T. mediterraneus* ssp. *ponticus* and *T. mediterraneus* ssp. *mediterraneus* by electrophoretical method. Dobrovolov (1986) revealed that the occurrence of large form can be explained as a result of heterosis effect between the above-mentioned subspecies.

Turan (2004) analysed the population structure of *T. mediterraneus* in Turkish coastal waters using morphometric and meristic traits and reported on population structuring in three areas: the Black Sea, Marmara Sea and the north-east Mediterranean Sea. The samples from the Black Sea were similar to each other for both morphometric and meristic charactrers. Biometric indices were insufficient to distinguish two horse mackerel subpopulations in the Bulgarian and Turkish Black Sea waters (Yankova and Raykov, 2006a). The same authors concluded that all of the morphological differences are possible due to variability of the habitat and sample size of the study. Acording to Prodanov *et al.,* (1997) the Black Sea horse mackerel represent a single population, as the environmental conditions are almost one and the same in the whole area inhabited, and there exists no positive evidence for the occurrence of two distinct subpopulations differing substantially in their biological parameters. The present mtDNA analysis also indicated that there were no subspecies of *T. mediterraneus* from the Turkish Black Sea waters (Bektas and Belduz, 2008).

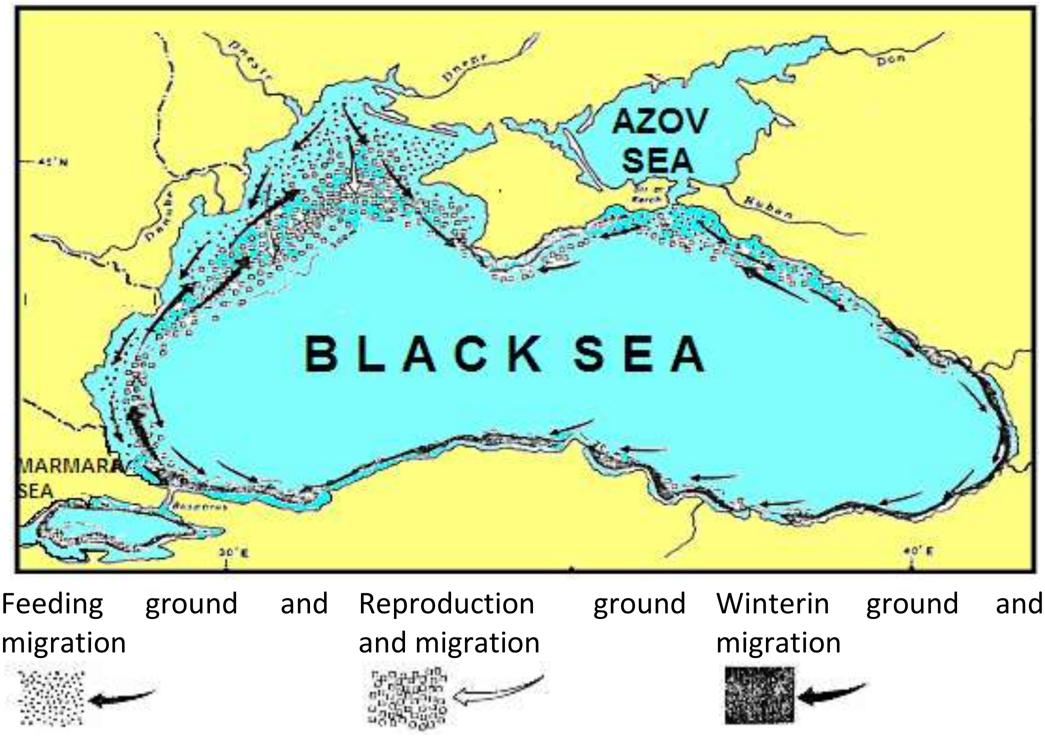
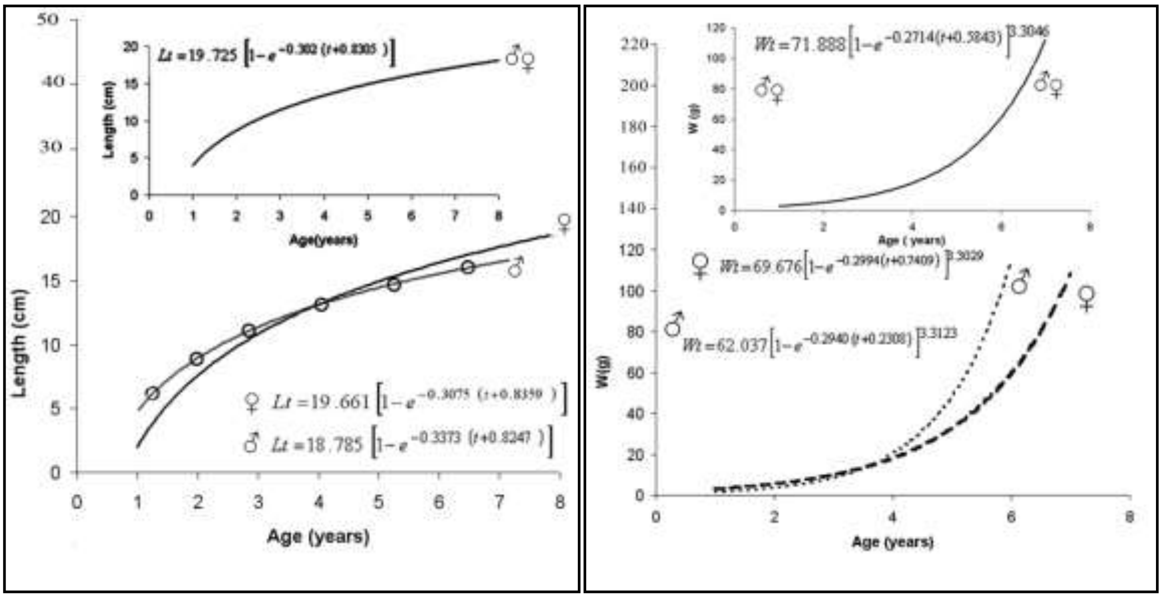


Fig.6.4.1.1.1 Distribution and migration routes of horse mackerel in the Black Sea.

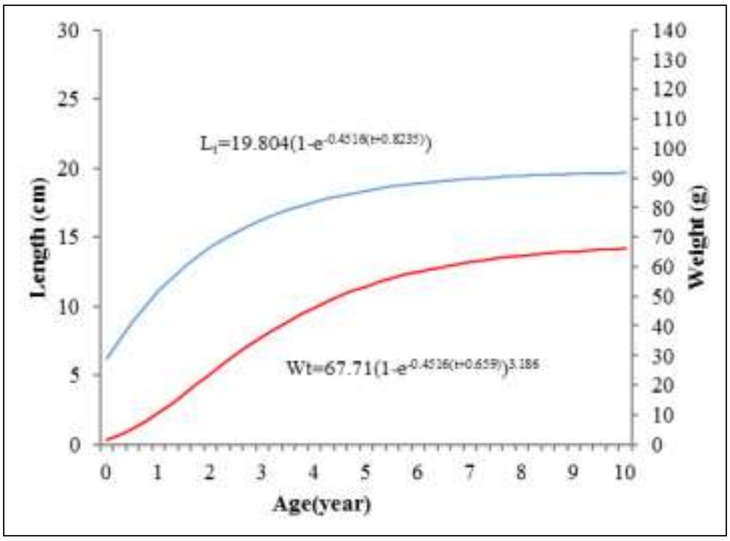
6.4.1.2 Growth

Horse mackerel growth parameters from VBGF and length-weight relationship, provided by different countries are presented in Table 6.4.1.2.1.

The exponent *b* ranged between 3.3029 for females and 3.3123 for males, exhibiting positive allometric growth (Yankova *et al.,* 2010). There was not a significant difference when the length-weight relationships of the sexes were compared using covariance ($P > 0.05$). The slope (*b* value) of the length-weight relationship was similar for males (3.3123) and females (3.3029), indicating that weight increased allometrically with length (Yankova *et al.,* 2010; Yankova, 2013a; Yankova, 2013b Yankova, 2013c; Yankova, 2014b).



(A)



(B)

Figure 6.4.1.2.1. Length-weight growth curves of horse mackerel males, females and both sexes combined from Bulgarian Black Sea waters (A-after Yankova *et al.,* 2010; B- after Genç *et al.,* 2013).

Comparison of the growth parameters of horse mackerel in Bulgarian Black Sea waters (Yankova *et al.,* 2010) showed that there were no differences (ANOVA, $F = 1.40$, $P > 0.05$). During the first 3 years of life females and males differ in length (Figs. 6.4.1.2.1). Males are characterized by higher growth rates than females (Yankova *et al.,* 2010).

In the Turkish Black Sea, the asymptotic length of *T. mediterrenaus* varied from 18.50 to 26.09 cm and there was a big difference in 1998 data, which was 38.95 cm (Kayalı, 1998). These values did not differ much when compared with L_∞ and K values estimated by other authors.

All estimated b values are within the range from 2.955 to 3.305. In the literature, b-values outside of this range are generally considered to be erroneous (Ricker, 1975). Almost all analyses showed positive allometric growth (b>3). There are some differences between parameters a and b sampled from the Black sea basin and with those obtained by other authors. Differences are likely due to number of specimens examined, differences in the utilized length ranges, research seasons, area and availability of food.

Table 6.4.1.2.1. VBGF parameters calculated in the Black Sea

COUNTRY	YEAR_PERIOD	SPECIES	SEX	L_INF	K	t_0	A	b
Bulgaria	2007-2008	HMM	C	19.75	0.3020	-0.830	0.0035	3.3046
Bulgaria	2007-2008	HMM	M	18.785	0.3373	-0.825	0.0034	3.3123
Bulgaria	2007-2008	HMM	F	19.661	0.3075	-0.836	0.0038	3.3029
Bulgaria	2013	HMM	C	20.98	0.2839	-0.71	-	-
Romania	2000	HMM	C	18.6	0.224	-1.430	0.0380	2.3552
Romania	2001	HMM	C	18.95	0.268	-0.630	0.0470	2.3501
Romania	2009	HMM	C	18.42	0.42	-0.410	0.0450	2.3469
Romania	2010	HMM	C	20.03	0.302	-0.467	0.0111	2.9065
Romania	2011	HMM	C	17.37	0.371	-0.445	0.0101	2.9101
Romania	2012	HMM	C	16.84	0.2686	-1.811	0.01075	2.883
Romania	2013	HMM	C	16.842	0.47	-1.1078	0.017884	2.6774
Turkey	1991 – 1992	HMM	M	19.9	0.396	-1.020	0.0110	3.18
Turkey	1991 – 1992	HMM	F	20.6	0.356	-1.110	0.0080	2.993
Turkey *	2005	HMM	C	20.237	0.3181	-1.603	0.0081	2.9983

Turkey *	2006	HMM	C	22.394	0.241	-1.932	0.0064	3.0986
Turkey *	2007	HMM	C	22.232	0.2554	-1.828	0.0085	2.984
Turkey *	2008	HMM	C	22.244	0.2538	-1.80	0.0069	3.1018
Turkey *	2009	HMM	C	24.023	0.2082	-2.075	0.0062	3.1024
Turkey *	2010	HMM	C	25.002	0.187	-2.11	0.0052	3.1654
Turkey *	2011	HMM	C	24.44	0.235	-1.767	0.0056	3.1402
Turkey *	2012	HMM	C	21.36	0.287	-1.84	0.0059	2.8831
Turkey *	2013	HMM	C	19.804	0.4516	-0.8235	0.0050	3.1862
Ukraine	2008	HMM	C	18.5	0.343	-0.66	-	-

**data according "Purse seine fisheries monitoring project by Trabzon Central Fisheries Institute"*

Length Frequency Distributions of Horse mackerel have changed year to year. In 2005, the distribution seems to be different. A LFD plot is given for the first 9 years in the South Black Sea (Turkey) (Fig 6.4.1.2.2.).

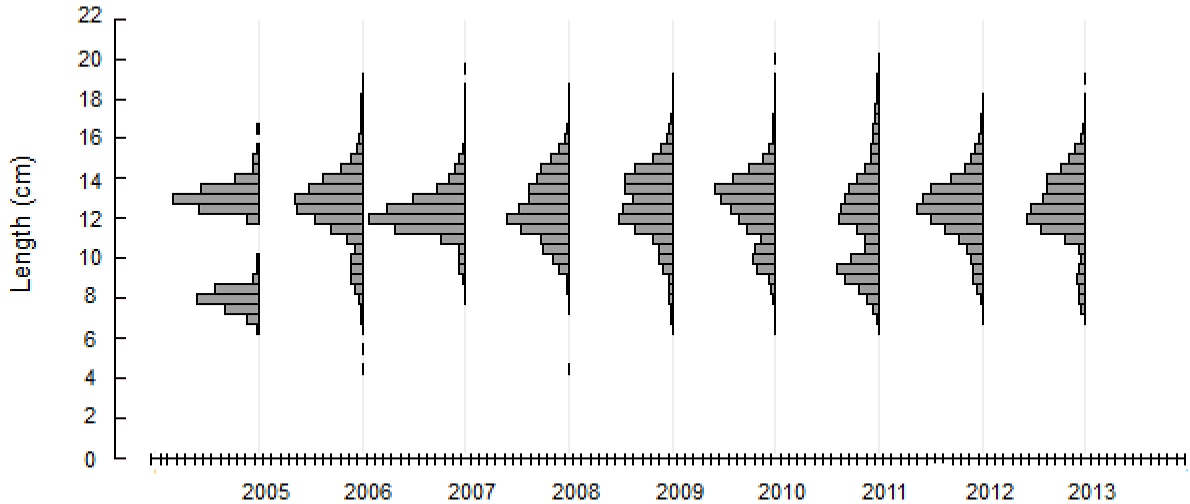


Figure 6.4.1.2.2. Length Frequency Distributions of Horse mackerel between 2005 and 2013 in Turkey (Genç *et al.*, 2014)

6.4.1.3 Maturity

The horse mackerel matures at age of 1-2 years during the summer, which is also the main feeding and growing season. It spawns in the upper layers, mainly in the open part of the sea as well as near the coast (Arkhipov, 1993). Eggs and larvae are often found in areas with a low productivity and higher salinity (Arkhipov, 1993). Daskalov (1999) has found that horse mackerel recruitment is related to divergence and increased productivity of the sea. Peak spawning in the Bulgarian Black Sea Coast falls between June-August (Georgiev *et al.,* 1961; Georgiev and Kolarov, 1962; Georgiev *et al.,* 1962; Stoyanov *et al.,* 1963, Karapetkova and Zhivkov, 2006; Yankova and Raykov, 2009; Yankova, 2011; Yankova M., 2014a). Spawning has been reported to occur 20 miles off the coast (Georgiev *et al.,* 1962). The pelagic eggs are 0.73-1.00 mm (Georgiev *et al.,* 1961; Georgiev *et al.,* 1962; Stoyanov *et al.,* 1963) and hatch after four days (Radu and Radu, 2008) at local temperatures 16-26 °C and salinity is 15.5-19‰ (Georgiev *et al.,* 1961; Georgiev *et al.,* 1962; Stoyanov *et al.,* 1963). The eggs of horse mackerel are pelagic, spherical, with a drop of fat (Karapetkova and Zhivkov, 2006).

The horse mackerel reproduction start at age of 1 year during the summer in Southern Black Sea (peak July), reproduction temperature is between 18-25 °C , salinity is 16-18 ‰ (Genç *et al.,* 1999).

6.4.2 Fisheries

6.4.2.1 General Description

The horse mackerel (*Trachurus mediterraneus*) fishery operates mainly on the wintering grounds in the southern Black Sea using purse seine and mid-water trawls. However, in the last two years, between the months of January-March, catches have increased. The horse mackerel of age 1-3 years generally prevails in the commercial catches, but strong year classes (for example, the 1969-year class) may enter into exploitation at age of 0.5 year and may prevail up to age 5-6 years. Over the last 40 years, highest horse mackerel catches were reported in the years preceding *M. leidyi* outbreak (1988-1990). (Prodanov *et al*., 1997; FAO, 2007). The maximum catch of 141 thousand tons was recorded in 1985, of which ~100 thousand tons were caught by Turkey (Prodanov *et al*., 1997). In the next four years catches remained at the level of 97-105 thousand tons. In the period 1971-1989, the stock increased, although years of high abundance alternated with years of low abundance due to year class's fluctuations, typical of this fish. VPA estimates showed that the stock was highest in 1984-1988 (Prodanov *et al*., 1997). Scientists (Chashchin, 1998) believed that the intensive fishing in Turkish waters in 1985-1989 has led to overfishing of horse mackerel population and reduction of the stock and catches in the next years. A drastic decline in stock abundance occurred after 1990 when the stock diminished by 56%. In 1991 the horse mackerel stock dropped to a minimum of 75 thousand tons and the catch dropped to 4.7 thousand tons that is a twenty fold reduction compared to the average annual catch in 1985-1989.

The horse mackerel recruitment has been highly variable with the stock biomass supported by sporadic strong year-classes (e.g. 1969, 1983, 1987) followed by weak-ones. Thus, the influence of a strong year-class can be traced through the subsequent few years of biomass increase. No evidence of reliable stock-recruitment relationship has been found (Daskalov, 1999). The relationship with selected environmental variables has been explored by (Daskalov 1999, 2003; Yankova *et al*., 2013). A strong negative correlation with surface temperature (SST) has been found. It may appear surprising for a warm-water summer spawning species to correlate negatively with SST. Such relationships have been also found however in other studies (Simonov *et al*., 1992). The effect of the wind stress was significant and generally positive. These results indicate that horse mackerel recruitment has been more abundant in years with increased physical forcing and enrichment, probably related to the spawning distribution wide spread over areas of low productivity.

During 1985-1993, only in 1988 a relatively successful recruitment was recorded. Despite of its coincidence with the first year of *M. leidyi* outbreak, the juveniles from this cohort were sufficiently well supplied with food. As the first burst of *M. leidyi* occurred in the autumn of 1988, the summer zooplankton maximum production did not suffer much from the devastating effect of *M. leidyi*. The copepods *Oithona nana* and *Oithona similis*, constituting the main food of larval horse mackerel (Revina, 1964), were especially abundant. However, the favorable trophic conditions for larvae in summer 1988 failed to ensure the formation of numerically strong year-class because further in the year juveniles were faced with strong feeding competition with *M. leidyi*. Sharp decline in *Oithona* under the predation pressure of *M. leidyi* in the subsequent years (Vinogradov *et al*., 1993) affected the survival of horse mackerel. Dietary studies of juvenile and adult horse mackerel (Revina, 1964) have shown that both the habitat diet of juvenile horse mackerel and *M. leidyi* overlap, therefore the strong feeding pressure by *M. leidyi* on zooplankton directly affected larval and juvenile horse mackerel. Food in relation to fish size shows that the most important for the diet of horse mackerel groups are *Mysidacea* and *Pisces.* The contribution of the rest of groups was relatively low (Yankova & Raykov, 2010). The same authors reveal that main prey of the Black Sea horse mackerel is fish and zooplankton. This group represents over 55% of the total IRI and was the main food for this species. Besides having the largest number of zooplankton, it had a high impact on populations of commercial fish such as sprat and anchovy.

In contrast to anchovy and sprat, the horse mackerel stock still remains in a depressed state. The total catch (taken predominantly by Turkey) in 2000-2005, remains ~10 th. t, similar to the pre-industrial period 1950-1975.

The catches of Black sea horse mackerel were realized by active (bathypelagic trawls and surrounding nets) and passive fishing gears (gill netting, trawl net, trap nets) (Prodanov *et al.,* 1997; Yankova *et al.,* 2010a). The Bulgarian and Romanian catches are taken primarily by passive, while the Turkish and former USSR entities by active gears (Prodanov *et al.,* 1997). The accuracy of the stock assessments depends exclusively on the fishery statistical data (Prodanov *et al.,* 1997). There are lack of information on horse mackerel catches or its underestimation by Russia, Ukraine and Georgia, Romania and Bulgaria enhances the risk of an incorrect assessment of biomasses. The improvements of fishing gears and the application of modern echo-acoustics further contribute to a more effective fishery (Prodanov *et al.,* 1997). The same authors reported that when the level of the horse mackerel stock was low, even small catches caused higher fishing mortality, and vice versa. All this stresses the necessity of annual assessments of stock size, of TAC`s, as well as of clarifying the causes (natural and anthropogenic) determining fluctuations in year class strength.

State of the fisheries in Turkey

Horse mackerel stock was a subject of overfishing, resulting in a fisheries collapse in the beginning of 1990’s (Ozekinei et al., 2001). The ratios of undersized individuals for horse mackerel were 89% and 92% for autumn and winter seasons, respectively. The corresponding ratios for the horse mackerel for the same seasons were 70 and 67%, respectively. Minimum allowable sizes for horse mackerel are 13 cm and 20 cm, respectively. The 50% cumulative values obtained during trawling trials are close to those figures. But the ratios of the undersize fish of horse mackerel (< 13 cm) for the seasons of spring, autumn and winter were calculated as 93.7, 75.8 and 30.7%, respectively (Dincer et al., 2007).

Production of the horse mackerel, which is the second most important pelagic catch along Turkey's Black Sea coasts, after the European anchovy, steadily increased until the mid-1980s and reached its maximum level of approximately 100,000 tons in 1985. The total amount of catch, however, constantly declined due to uncontrolled fishing activities and over-fishing in the 1990s and declined to 80,000 tons. Research into commercial fish stocks on Turkey's Black Sea coasts conducted during the second half of the 1980s indicated that the horse mackerel population suffered the greatest fall in terms of quantity after the sea-perch among the pelagic stocks in the past 15 years (Bingel et al., 1995; Zengin et al., 1998a; Zengin, 2001). The breakdown of horse mackerel caught by commercial fishermen between 1991 and 1993, when the amount of horse mackerel catch started to decrease along Turkish coasts, by length confirms this conclusion. The average lengths of horse mackerel caught by large purse-seine nets and trawlers during those years were 11.1 cm, 10.9 cm and 10.6 cm, respectively (Zengin, 1998). Average operating ratio (E) calculated for the same period was 0.78 (Genç et al., 1999), which clearly demonstrates the over-fishing of the horse mackerel stock. This sharp fall in the horse mackerel catch steadily increased until the end of the 1990s. The share of horse mackerel below optimal catch length (L_{opt}.= 13 cm) in the total catch caught by coastal surrounding nets in the eastern Black Sea early in the 1990s (1990-1993) was 52.2%, rose towards the end of 1990s (66.7 %) (Zengin et al., 1998a, Zengin et al., 2002) – Table 6.4.2.1.1. The length of the horse mackerel population off the southern Black Sea coast after they reach initial reproductive maturity is 11.7 cm (Genç et al., 1999). A large part of immature and young individuals below the optimal catch length (discards catch) are taken by coastal fishermen from stock and sold on the market under the counter or destroyed on the sea. In order to eliminate this trend, which is an indicator of growth over-fishing, new fishing methods and management planning are also considered necessary for horse mackerel populations.

After the beginning of the 2000s the landings started to increased again. Total Turkish Black sea catch was up to 26.000 tons (2006 official statistics) and the average length also increased 13.7 cm. (Genç et al, 2006). In the Black Sea coast of Turkey, horse mackerel production was 18979.4 tons in 2013, which covered 9% of the total fish landings in the same marine area. Horse mackerel production peaked between 1984-1990 with an average ranging 65.000-102.000 tons. They collapsed in 1991 (21000 tons). The following years, catch quantity varied between 8000-23000 tons. The fisheries of horse mackerel can be divided in three groups. These groups are purse seine, trawl (pelagic and bottom) and gillnet long line. The length of purse seine and trawl vessels is between 12-64m and small vessels are <12m. Some trawlers (particulary Samsun Shelf Area) catch anchovy, sprat and horse mackerel. Purse seiners are mainly fishing anchovy, bonito, horse mackerel and blue fish during the fisheries season. Long lines are catching whiting, red mullet, horse mackerel, bonito, blue fish etc. during the all year. There is no fisheries restriction to long line. Almost the whole horse mackerel catch is obtained by purse seine in all fishing seasons. Long lines are catching whiting, red mullet, horse mackerel, bonito, blue fish etc. during the all year. Horse mackerel can be found almost in all year in the coasts of Turkey. There was an increase in the amount of this species in the last two years. However, it declined in 2013. Its migration was from west to east. According to common opinion, this species is coming from Ukrainian or Georgian coasts to our coasts and, later it continues migration. 0+ age group and large-scale schools in the same cohorts were found in the last two years (Ak and Dağtekin 2014).

Horse mackerel isn't the first target species the large-scale purse seiners when there is bonito, bluefish and anchovy. However, when the amounts of these species are low, these vessels are targeting horse mackerel as soon as possible. In a large purse seine vessels, more than one net (horse mackerel net, anchovy net, bonito net) are normally available.
Some vessels in fishing period of anchovy, due to discontinuous catch within the period of anchovy, were directed to horse mackerel fishing.

Operations of purse seine for horse mackerel is done often in coastal areas (<4 nautical miles). Purse seine vessels can operate 24h but especially during the day. Fisheries time is 9-10 hours, number of purse seine operation number can vary from 1 to 4 on a day.

Horse mackerel stocks in the Black Sea are usually caught by Turkish fishermen by using active (purse seine, bottom trawler, pelagic trawler) and passive (gillnet and longline) nets Table 6.4.2.1.2.The remaining part of the catch is caught by purse seine. A large part of the catch is caught in the autumn and the first part of winter (September-December) (Fig. 6.4.2.1.1).
The remaining part of the catch is caught by bottom trawler, pelagic trawler, extension net and long lines.

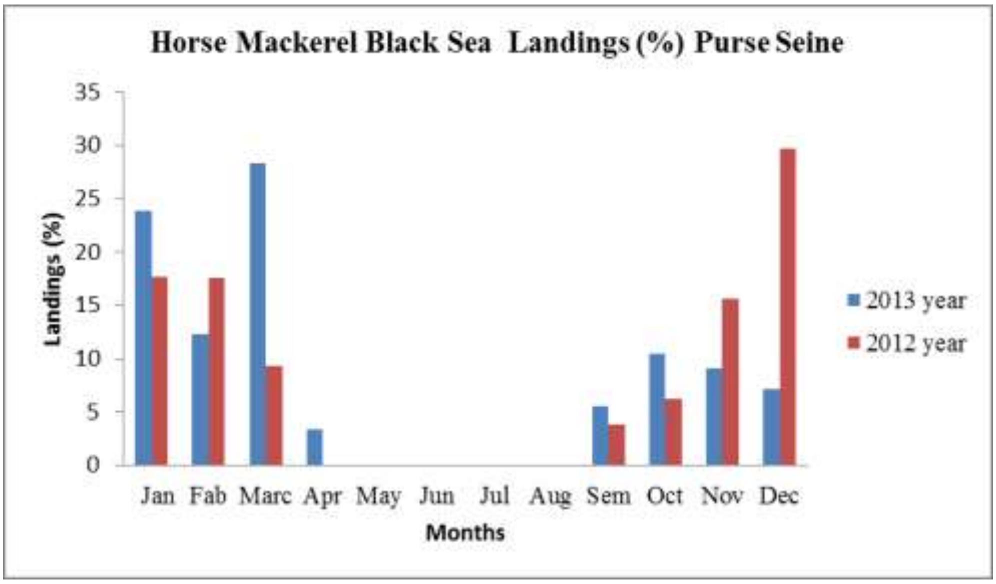


Figure 6.4.2.1.1. Landings (%) distribution of the Horse mackerel in the south Black Sea by purse seine.

Table 6.4.2.1.1. Distribution of average length (cm) and catches below the optimum catch length (L_{opt}) in the southern Black Sea in the period between 1990 and 2012.

Fishing season	Landings (tons)	Optimum catch length (cm)	Mean weight(g)
1990	75882	11.1	-
1991	25679	10.9	-
1992	20989	10.1	-
1993	23945	-	-
1994	25275	-	-
1995	15809	-	-
1996	16093	-	-
1997	11097	-	-
1998	8246	-	-
1999	8331	-	-
2000	16181	12.4	-
2001	16750	-	-
2002	8903	-	-
2003	9213	-	-
2004	9113	13.1	-
2005	17003	11.6	15.70
2006	25927	12.7	17.69
2007	17429	12.6	16.71
2008	20124	13.2	20.57
2009	15905	12.6	17.09
2010	12929	12.1	17.00
2011	17746	11.92	15.52
2012	23911.2	12.75	17.79
2013	18979.4	12.73	17.93

Table 6.4.2.1.2 % catch and catch per unit effort according to type of net in the south Black Sea in the period of between 1990 and 2000

Fish species	Parameters	Purse seine	Trawl	Pelagic trawl	Gill-nets	Set-net	Long-line
Horse mackerel	%Catch CPUE (kg/boat/day)	98.2 3837.5 (600-10000)	0.3 -	0.4 2038.7 (95.9-79.20)	0.9 -	-	0.2 -

Management measures in Turkey:

Horse mackerel fishery in Turkey was firstly promoted by the Commercial Fishery Advice of General Directorate of Fishery (dated 14.08.1997, No: 23080 regarding the years 1997-1998, Section 2. Article 15). This arrangement was followed by new management criteria brought into force for horse mackerel fishery (Ak and Dağtekin, 2014). These measures cover:

- Minimum catch size: 13 cm total length.
- Fishing area: There are no restrictions for fishing areas.
- Fishing gear: Fishing is allowed for purse seiners, trawlers, gillnet and long liners.
- Time periods: Though pelagic fishing period starts in 1 September and lasts to 30 April bottom trawling ends in 15 April. There is no limitation in distance from the coast for pelagic trawling. Horse mackerel fishing can be done all day.
- Depth: The pelagic fishery is banned in waters shallower than 24 m in all seasons.
- Others: Small pelagic have to be carried in cases or boxes with net weight of 12 kg (± 10%). Certificate of origin and transportation is essential. Fisheries cooperatives are authorized for the issuing of this document

State of the fisheries in Ukraine

After a long absence, since the end of 2002, was renewed fishing of horse mackerel in the waters under the jurisdiction of Ukraine. Horse mackerel forms aggregations during the wintering and to a lesser extent, in the autumn on migration routes. The Ukrainian waters near the Southern coast of Crimea from November to March it occur wintering ground of horse mackerel. In the formation of wintering aggregations of horse mackerel it possible for fishing by lifting cone-shaped nets with electric light attraction, and purse seines. In the warm season in small quantities horse mackerel is harvested with pound nets, including the Sea of Azov. In recent years the number of horse mackerel midwater trawl is caught as by-catch in fisheries sprat. Generally, the share of Ukrainian total catch in the catch of mackerel in the Black Sea is very low.

Upon a characterization of commercial use of the Horse mackerel stock in Ukraine, two periods clearly stand out: 1992-2001 years and since 2003 up to the present. During the first of mentioned periods Horse mackerel was practically absent as an object for Ukrainian fishing. Absence of commercial catches in the waters of the Black Sea under Ukrainian jurisdiction during 1992-2001 has an explanation in the considerable decrease of its stock number, which, in V. A. Shlyakhov and A. N. Grishin's opinion (2009), was conditioned by the negative influence of Ctenophora Mnemiopsis. As these authors points, the introduction of Ctenophora Beroe, that had led to decrease of negative influence of Mnemiopsis, has influenced well on the Horse mackerel stock state. Since 2003 it regains its commercial significance, and its Ukrainian catches vary on the level of several thousand tons.

Horse mackerel forms aggregations during wintering and, to lesser extent, in the autumn on migration routes. It winters in Ukrainian waters near the Southern coast of Crimea from November to March, and some years can be found from c. Takil to c. Lucull. Upon forming wintering aggregations the possibility of specialized fishing of Horse mackerel with lifting cone-shaped nets with electric light attraction appears, and to lesser extent, of fishing with purse seines. But the aggregations of commercial character form not every year, thus the specialized fishing of Horse mackerel is carried out occasionally and only in certain years. As a rule, the most part of Horse mackerel is caught with midwater trawls as by-catch at sprat fishing. During warm seasons Horse mackerel is caught with pound nets in small amounts. Under mentioned peculiarities of distribution, the prevalent part of the Horse mackerel year catch falls on I and IV quarters. The age structure of Horse mackerel catches differentiates significantly in different years, herewith the prevalence of individuals of one-two generations is characteristic in catches (Shlyakhov et al., 2012) (Table 6.4.2.1.3).

Table 6.4.2.1.3 Age structure of horse mackerel commercial catches in the waters of the Black Sea under the jurisdiction of Ukraine during 2003-2012.

Year	Average weight (g)	Age composition (%)					
		0+	1-1+	2-2+	3-3+	4-4+	5-5+
2003	18.1	-	1	97	2	-	-
2004	29.4	1	2	6	91	0	-
2005	23.3	-	30	50	15	5	-
2006	17.4	-	67.7	13.1	18.9	0.3	-
2007	18.2	-	51.1	20.4	27.7	0.8	-
2008	17.9	0.9	24.8	63.3	10.3	0.5	0.2
2009	23.2	-	-	16.9	55.8	24.0	3.3
2010	12.8	46.4	52.8	0.8	-	-	-
2011	17.5	9.1	80.4	4.5	3.8	2.2	-
2012	14.3	30.0	8.0	50.5	11.4	-	-

Table 6.4.2.1.4. Horse mackerel fishing mortality (F) by Jones method (Ukrainian waters after Shlyakhov et al., 2013.).

Year										
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
FL, mm										
146-150	0.243	1.340	1.826	0.532	1.194	0.499	1.299	1.370	0.638	0.193
151-155	0.280	1.049	2.099	0.624	0.638	0.373	1.199	3.841	0.184	0.347
156-160	0.342	1.177	0.843	0.637	0.547	0.357	0.720	0.342	0.211	0.170
161-165	0.463	0.479	0.463	0.742	0.903	0.186	0.463	0.463	0.256	0.350
L145-165	0.332	1.011	1.308	0.634	0.820	0,354	0,920	1.504	0.322	0.265

6.4.2.2 Management regulations applicable in 2012 and 2013

The STECF EWG will provide a full description of national and international regulations regulating the horse mackerel fisheries during its next meeting in 2015.

6.4.2.3 Catches

6.4.2.3.1 Landings

The data set of landings was compiled for the period 1950 – 2013. It is evident (Table 6.4.2.3.1.1) that during the periods (1956 – 1965) the catches have continued to grow and their mean values reached – 19007.95 tons. During the period 1966 – 1975 the total average catch increased to

21041.98 tons. The next decade (1976 – 1985) the horse mackerel catches have also increased from 20576.3 to 141077.8 tons, respectively. The period 1986 – 1995 was characteristic with abrupt decline in the catches of the fish from 977408 to 15906 tons. The next 7 years (1996 – 2002) represented a period of prolonged decreasing of the mean horse mackerel catch- mean values reached-12343.64 tons.

The data of Bulgarian catches show considerable fluctuations, they could be distinguished in two stages (Yankova *et al.*, 2009). In the first stage from 2000 to 2003 years, relatively high amounts of catches are evident. In 1992 was realized catch of 165 t. Last relatively high catch amount of 141.6 t was reported in 2003. Upon 1993 the amounts of catches suddenly dropped particularly in 1994-1999 period, when the landings fluctuated from 30 t in 1999 to 80 t in 1994. The last investigated years are characterized by a trend of considerable increase of horse mackerel catches. Comparison with 2007 substantially increase (round about 55%) was reported in catches of horse mackerel, which is the amount was 179.8 t for 2008 (data source -official statistics of the National Agency of Fisheries and Aquaculture).

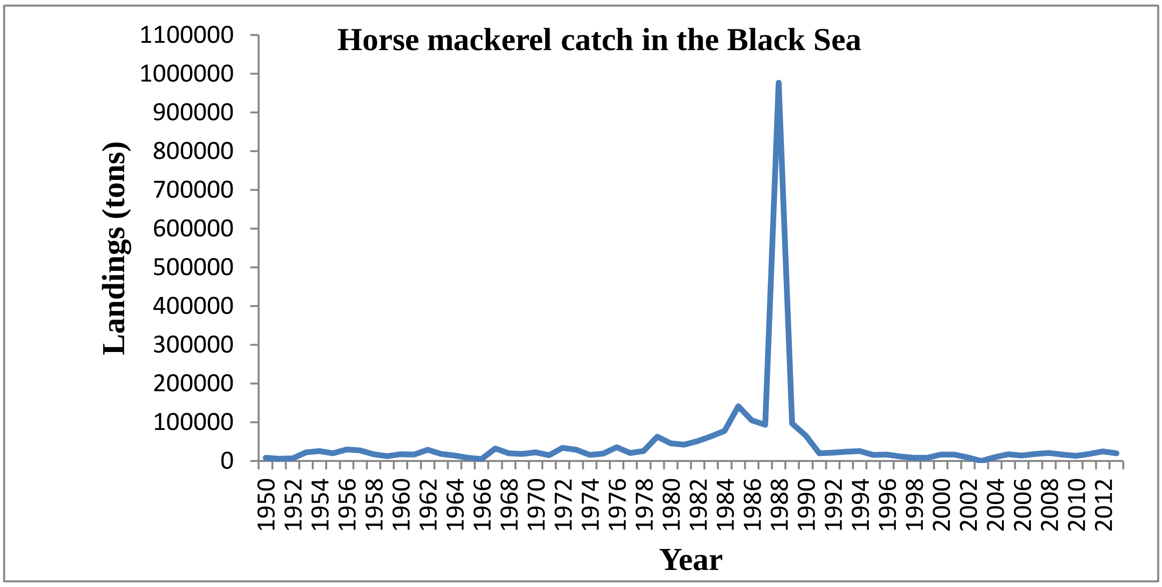
Table 6.4.2.3.1.1. Black Sea horse mackerel landings (in tonnes) by countries during the period 1950-2013.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Total
1950	644.4	-	217.0	-	1200.0	-	8291.4
1951	736.2	-	293.0	-	2500.0	-	5399.2
1952	564.9	-	260.0	-	2600.0	-	6474.9
1953	294.7	-	140.6	-	9200.0	-	22094.7
1954	593.2	-	617.8	-	12200.0	-	25511.2
1955	662.4	-	297.4	-	7200.0	-	19950.4
1956	131.5	-	63.5	-	14200.0	-	29734.5
1957	69.4	-	119.7	-	14000.0	-	26919.4
1958	233.0	-	587.4	-	4900.0	-	17370.0
1959	687.4	-	839.8	-	700.0	-	12687.4
1960	1017.7	-	674.6	-	4800.0	-	17691.7
1961	1240.6	-	2200.0	-	3600.0	-	16345.6
1962	805.2	-	1166.0	-	13500.0	-	29271.2
1963	231.4	-	532.0	-	3500.0	-	18163.4
1964	242.0	-	248.4	-	3100.0	-	13790.0
1965	301.6	-	1364.7	-	1200.0	-	8106.3
1966	556.7	-	1770.0	-	600.0	-	5276.7
1967	245.7	-	762.0	-	24615.0	-	32111.7
1968	37.4	-	175.0	-	4750.0	-	20124.4
1969	95.9	-	156.0	-	16762.0	-	18293.9
1970	689.1	-	1342.0	-	19380.0	-	22041.1
1971	630.9	-	1218.0	-	8722.0	-	14920.9
1972	534.0	-	500.0	-	10855.2	-	33709.2
1973	849.0	-	606.0	-	16593.7	-	28828.7
1974	2168.8	-	608.0	-	10244.8	-	15904.6
1975	1972.8	-	1003.0	-	11897.8	-	19208.6
1976	1808.7	-	1514.0	-	14077.9	-	35745.6
1977	791.0	-	404.0	-	14674.3	-	20576.3
1978	565.0	-	729.0	-	23529.0	-	25508.0
1979	934.5	-	1179.0	-	59772.0	-	62619.5

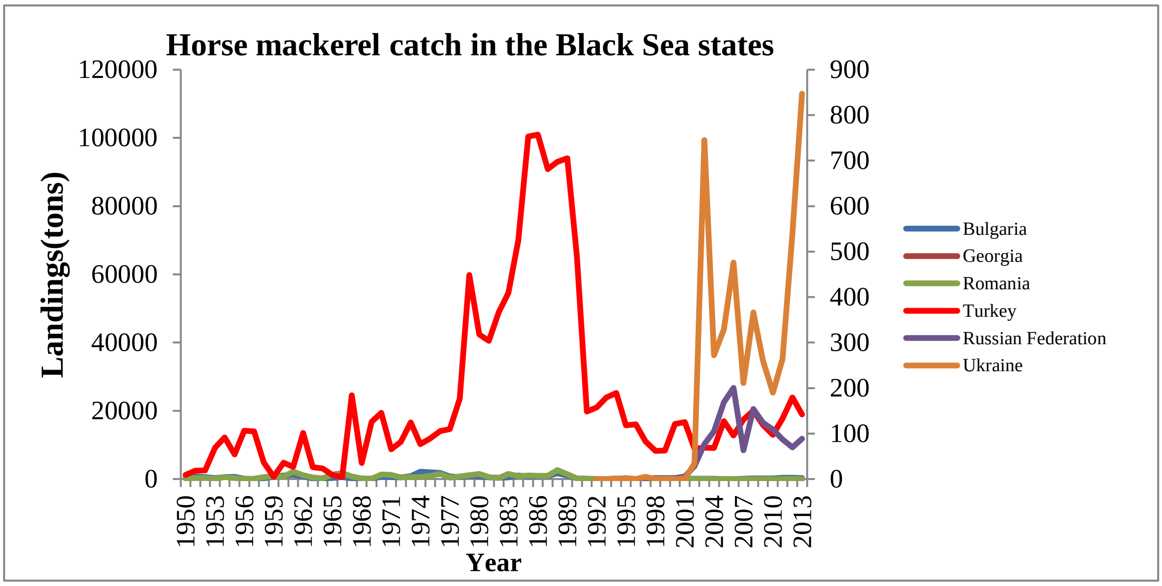
1980	813.0	-	1536.0	-	42339.0	-	45297.0
1981	476.2	-	588.0	-	40543.0	-	41951.2
1982	366.8	-	291.0	-	48918.0	-	51450.8
1983	496.7	-	1510.0	-	54548.0	-	63711.7
1984	1015.8	-	872.0	-	69980.0	-	77369.8
1985	755.8	-	1035.0	-	100417.0	-	141077.8
1986	850.9	-	945.0	-	100943.0	-	105108.9
1987	826.4	-	997.0	-	90850.0	-	93216.4
1988	1676.8	-	2660.0	-	93006.0	-	977408
1989	1100.9	-	1459.0	-	94023.0	-	96887.9
1990	164.1	-	165.0	-	65163.0	-	65548.1
1991	122.9	48.0	0	-	19781.0	-	19954.9
1992	54	0	22	0	20989	0	21065
1993	31	0	30	0	23945	0	24006
1994	80	0	35	1	25275	1	25392
1995	70	0	24	1	15809	2	15906
1996	68	0	10	0	16093	0	16171
1997	36	18	1	0	11097	5	11157
1998	40	13	15	2	8246	0	8316
1999	30	0	3	2	8331	1	8367.2
2000	111	35	8	2	16181	0	16336.8
2001	130	7	17	6	16750	1	16911
2002	141.5	19	21	28	8903	34	9146.5
2003	141.6	70	10	77	9213	745	10256,6
2004	73.9	56	14	105	9113	272	9633.9
2005	29.4	60	12	169	17003	329	17602.4
2006	62.834	55	19	200.5	12812	476	13625.33
2007	115.88	53	14	63.2	17429	211	17886.08
2008	179.607	8	11	154.24	20124	366	20842.85
2009	176.91	6*	17	124.04	15905	260	16489.06
2010	165.27	5*	7	108.86	12929	190	13405.50
2011	394.84	44**	22.820	87.21	17746	264	18558.87
2012	381.37	44	20.005	69.50	23911.2	539.713	24931.36
2013	271.38	0	26.325	89	18979.4	847.405	20113.51

Remark: * expert assessments;** oral announcement in meeting AG FOMLR/Commission 2011

In 1992 was achieved a catch of 21065 t. Upon 1994 the amounts of catches decreased especially in 1998-1999 period. In 2013 decrease in catches of horse mackerel was reported, at the level of 20213.51t (Figure 6.4.2.3.1.1A).



A.



B.

Figure 6.4.2.3.1.1 Trend in total (A) and by countries (B) horse mackerel landings in the Black Sea.

6.4.2.3.2 Discards

No discards have been reported for the horse mackerel fishery.

6.4.2.4 Fishing effort

No information has been available during the EWG 14-14 meeting.

6.4.2.5 Commercial CPUE

Table 6.4.2.5.1. CPUE kg. day/per vessels of horse mackerel in Turkey, during the period 2000-2013.

Year	Number of purse seine vessel	Landing amount (tones)	CPUE (kg.day/per vessels)
2000	262	16181	1543.989
2001	220	16750	1903.409
2002	136	8903	1636.581
2003	145	9213	1588.448
2004	138	9113	1650.906
2005	232	17003	1832.22

2006	199	12812	1609.548
2007	164	17429	2656.86
2008	192	20124	2620.313
2009	160	15905	2485.156
2010	168	12929	1923.958
2011	195	17746	2275.128
2012	181	23911.2	3302.652
2013	197	18979.4	2408.553

6.4.3 Scientific surveys

No specific fisheries independent scientific surveys have been conducted

6.4.4 Assessment of historical parameters

6.4.4.1 Justification

STECF EWG BLACK SEA 14-14 found out that data available in different national databases would allow performing a quantitative assessment of this stock. Data from the Turkish fisheries (~95% of the catch) will be very important but horse mackerel fisheries are quite important for rest of the Black Sea countries especially when the stock is high assuring a regular strong migration in the northern Black Sea. Catch effort and biological data (age and individual size and growth) were thoroughly compiled.

Table 6.4.4.1.1. Data availability by countries.

Type of data	Turkey	Romania	Bulgaria	Ukraine	Comment
Catch (monthly, quarterly, yearly)	yes	yes, monthly, 2006-2008	the end year 2008	the end year 2010	
IUU catches	only can be estimated	no	the end year 2008	No	expert est.: low level (not more then 10-15%)
Fishing gears	yes	yes	the end year 2008	Yes	trawls (by-catch), lift cone-shaped nets with electric light attraction, pound nets
Fishing seasons	yes	yes	the end year 2008	Yes	trawls: November-March; Lift cone-shaped nets: December-February; Pound nets:

					June-September
Fishing areas	yes	yes	the end year 2008	Yes	trawls & lift cone-shaped nets: Crimean waters; pound nets: Crimean & NW of Black Sea coastal waters, Crimean of Azov Sea coastal waters
Fishing and natural mortality estimations	yes	yes	no	2004-2009	
Mean individual weights	yes	yes	the end year 2008	2011	2003-2008
Catch-at-age	yes	yes		2004-2011	
Length and weight at age	yes	yes	yes	2011	
CPUE from commercial yield and surveys	indirectly		no	No	
Migration routes (spawning,fattening,wintering grounds)	indirectly	yes	yes	Yes	
Existing fishery regulations in country	yes	yes	yes	Yes	
Existing analyses for 1950-2009	some years; 1990-1993	yes	yes	Yes	in Turkey there are some poulation parameters for different yeras, different area and institution

6.4.4.2 Input parameters

Catch at age

Available data for earlier long-term observations and surveys conducted in Ukraine and the Russian Federation allow to conclude that the composition of the population of horse mackerel in the areas of these countries do not have serious differences. Therefore, it was decided to use the data concerning size and age composition of horse mackerel obtained in Ukraine also for the zone of the

Russian Federation. In the analysis of all data about the size and age composition available for the experts certain differences between the data obtained from the Ukraine and the data for the Turkish zone were revealed. Share of the group 0 + in the data for the area of Turkey was much higher. At the same time the average weight of individuals of group 0 + in Turkey was two and a half times lower. Obviously, these differences in the data are due to the fact that the purse seines were used in Turkey in the fishery of horse mackerel, which have a lower selectivity towards small individuals of horse mackerel than lifting traps with electric light used in Ukraine.

Table 6.4.4.1.1. Aggregated catch at age in number 10^3 of Bulgaria, Georgia, Romania, Russia, Turkey and Ukraine during the period 2005-2013.

Age Year	0	1	2	3	4	5	6
2005	24623.8	446026.448	510230.8371	117165.337	15977.07681	2078.610163	54.25073633
2006	7149.7177	289385.028	381781.7543	68877.6232	19612.52778	2295.03876	554.5081117
2007	596.92757	633607.85	364748.1832	61099.7537	5731.807176	2740.416069	0
2008	6678.3366	189996.56	556876.1004	232242.597	27287.16785	2573.869748	26.64733206
2009	3910.7335	395249.709	421199.273	92146.0061	37179.53485	6013.341588	998.3546439
2010	28029.157	300248.161	334444.5576	128585.373	55875.03503	18165.18663	6057.42282
2011	29325.467	715934.213	272264.7989	134564.125	23781.84854	7464.849154	3072.334567
2012	20740.433	692427.992	633694.9337	55724.1519	6778.735012	1088.402902	87.96761201
2013	380709.3	961880.3	326623.8	36617.1	2768.8	1399.8	44.8

Weight at age in the catch

Table 6.4.4.1.2. Weight at age in the catch (W-mean weight fish in catches, in g).

Age Year	0	1	2	3	4	5	6	W
2005	4.24	13.23	20.62	29.72	38.62	45.84	43.56	15.77
2006	4.94	13.77	21.19	29.34	42.06	51.82	57.20	17.70
2007	9.66	14.70	20.10	29.19	36.97	42.72		16.74
2008	4.79	12.66	23.07	30.28	39.00	50.90	41.25	20.52
2009	5.19	13.01	20.69	30.22	42.54	50.12	67.44	17.24
2010	4.37	10.05	21.85	28.46	31.43	36.81	63.36	15.38
2011	5.43	13.01	24.79	37.89	51.42	65.63	73.17	15.64
2012	6.52	14.39	23.18	33.49	34.62	49.41	39.88	17.68
2013	3.50	11.89	23.60	32.45	33.21	43.95	62.97	11.82

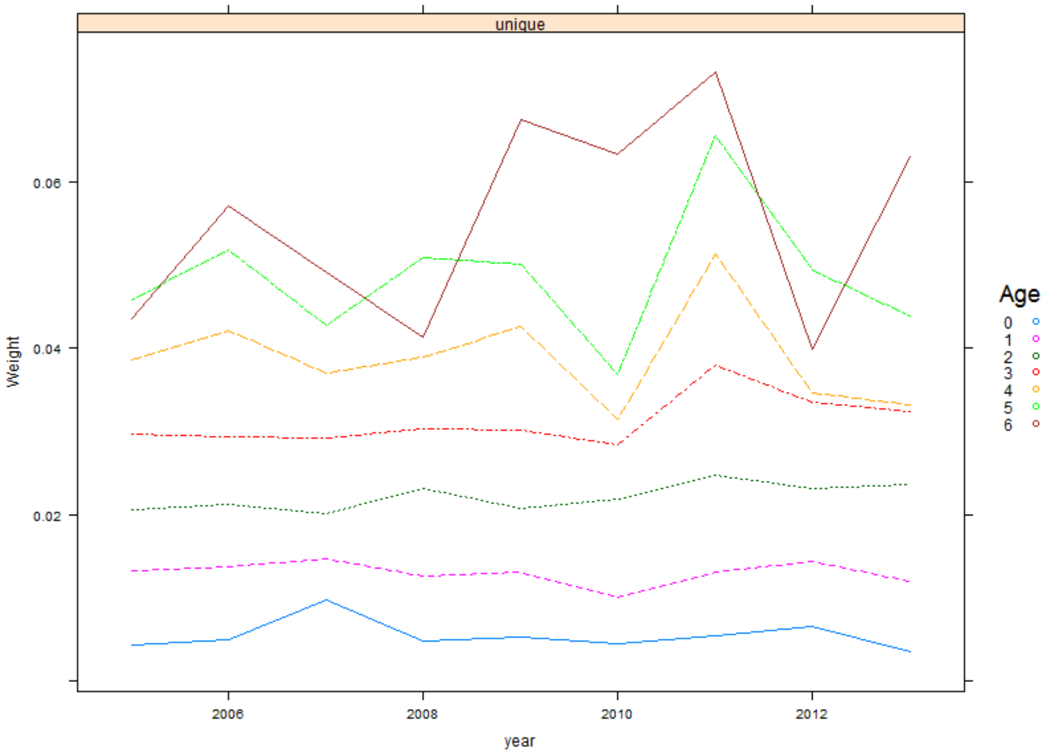


Figure 6.4.4.1.1. Horse mackerel individual weight at age from commercial fishery.

Table 6.4.4.1.3. Horse mackerel maturity at age.

Age Year	0	1	2	3	4	5	6
2005	0	0.8	1	1	1	1	1
2006	0	0.8	1	1	1	1	1
2007	0	0.8	1	1	1	1	1
2008	0	0.8	1	1	1	1	1
2009	0	0.8	1	1	1	1	1
2010	0	0.8	1	1	1	1	1
2011	0	0.8	1	1	1	1	1
2012	0	0.8	1	1	1	1	1
2013	0	0.8	1	1	1	1	1

A new tuning series from a commercial CPUE from Turkey (Table 6.4.4.1.4), not available for EWG 13-12, was available for this meeting (EWG 14-14) and has been used to tune an XSA model. Each age group catch was divided into the total landing. Rate in each age group were divided by the CPUE. Resulting value was multiplied by the weight in each age group. Each age group was divided by the total weight. Resulting values were multiplied by the CPUE. It is seen that CPUE is highbetween 1 and 3 age groups (Table 6.4.4.1.4).

Table 6.4.4.1.4. Tuning fleet data from Turkish commercial CPUE.

Age Year	0	1	2	3	4	5	6	TOTAL
2005	5.8	16.7	56.7	1571.7	0.0	0.0	0.0	1832.22
2006	9.5	526.5	932.5	305.1	50.3	8.2	8.2	1609.548

2007	3.8	402.2	896.5	199.8	91.0	12.7	3.5	2656.86
2008	0.1	1337.1	1054.3	233.3	24.9	7.1	0.0	2620.313
2009	3.4	264.5	1428.8	795.6	115.9	12.1	0.0	2485.156
2010	2.4	711.8	1200.6	340.9	187.1	33.3	9.0	1923.958
2011	14.1	351.1	848.6	417.4	181.9	65.9	45.0	2275.128
2012	14.0	913.6	662.3	497.8	116.3	48.6	22.5	3302.652
2013	4.9	1268.2	1811.3	199.5	13.3	5.4	0.0	2408.553

Table 6.4.4.1.5. Natural mortality matrix for Horse mackerel in Black Sea.

Age Year	0	1	2	3	4	5	6
2005	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2006	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2007	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2008	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2009	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2010	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2011	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2012	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2013	0.8	0.8	0.8	0.8	0.8	0.8	0.8

6.4.5 Assessment of historic parameters

6.4.5.1 Method: XSA

6.4.5.2 Justification

Given the availability of a tuning fleet of commercial CPUE from Turkey for years 2005-2013 an XSA(in FLR) was attempted.

6.4.5.3 Input data

Input data have been described in previous sections and are the same for the XSA. A first step taken before the XSA was to correct the catch at age data to the official landings (SOP corrections) since there where clear discrepancies.

The XSA was tuned with commercial catch rates series from Turkish fleet, over 2005-2013. Data from 2004 were discarded since covered only the first 4 ages and age 3 presented large catches (similarly to the assessment done in EWG 13-12)

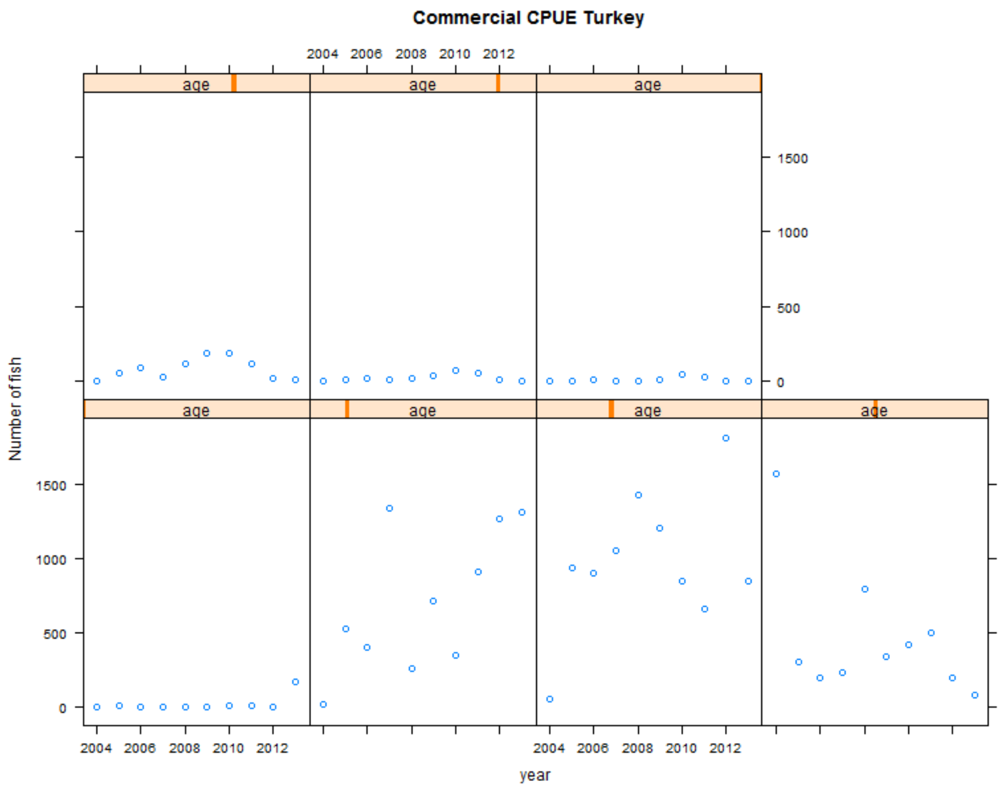


Figure 6.4.5.3.1. Turkish commercial CPUE series at age.

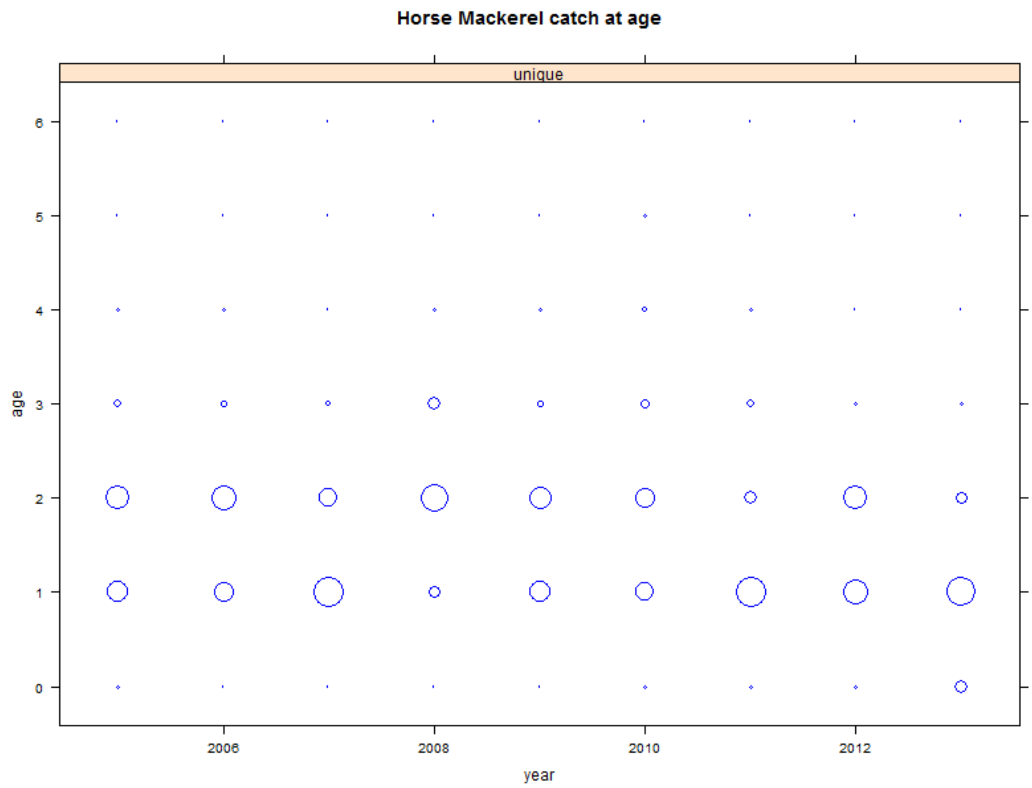


Figure 6.4.5.3.2. Horse mackerel catch at age in the Black Sea.

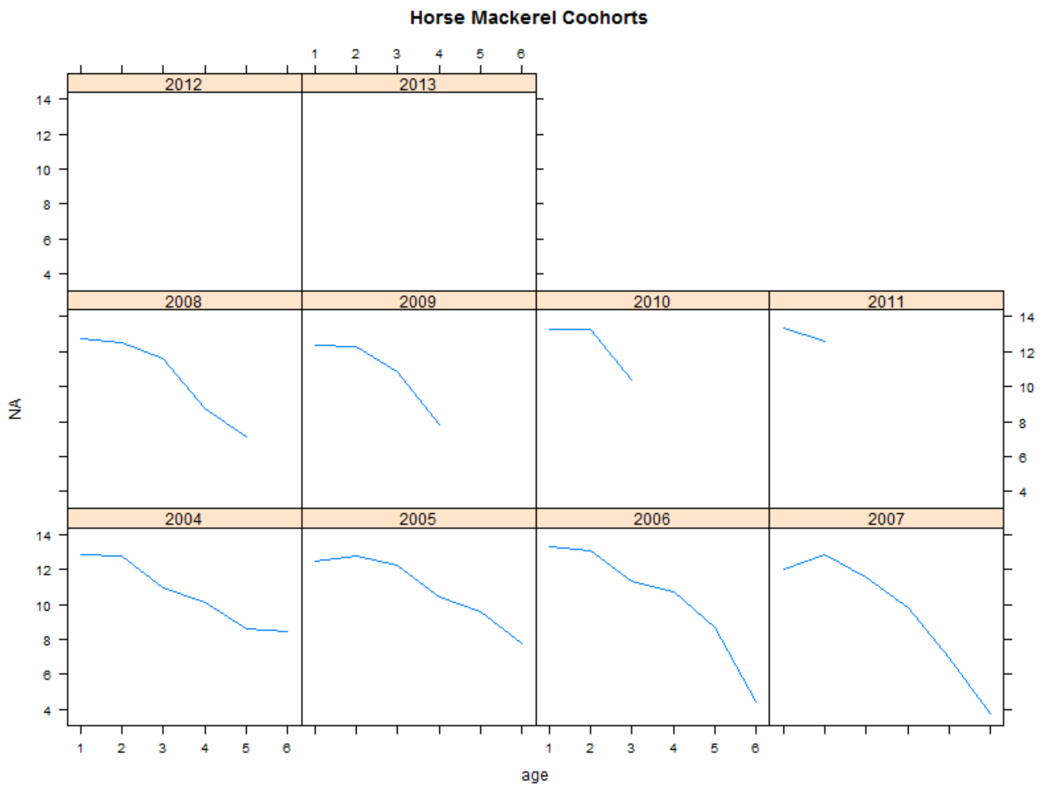


Figure 6.4.5.3.3. Cohorts for age 1-6 by year from catch numbers at age.

An object of class "FLStock"
FL stock input data is replicated below:
Slot "catch":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique
An object of class "FLStock"

year									
age	2005	2006	2007	2008	2009	2010	2011	2012	2013
all	17602	13625	17886	20843	16489	13406	18559	24931	20214

units: NA NA
Slot "catch.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year						
age	2005	2006	2007	2008	2009	2010
0	2.0916e+04	6.4487e+03	5.6901e+02	5.9199e+03	3.4646e+03	2.2213e+04
1	3.7886e+05	2.6101e+05	6.0397e+05	1.6842e+05	3.5016e+05	2.3794e+05
2	4.3339e+05	3.4435e+05	3.4769e+05	4.9363e+05	3.7315e+05	2.6504e+05
3	9.9521e+04	6.2124e+04	5.8242e+04	2.0587e+05	8.1635e+04	1.0190e+05
4	1.3571e+04	1.7690e+04	5.4637e+03	2.4188e+04	3.2939e+04	4.4280e+04
5	1.7656e+03	2.0700e+03	2.6122e+03	2.2816e+03	5.3274e+03	1.4396e+04
6	4.6080e+01	5.0014e+02	9.5322e-01	2.3624e+01	8.8447e+02	4.8004e+03

year
age 2011 2012 2013

```
  0 2.3399e+04 1.9189e+04 3.5265e+05
  1 5.7125e+05 6.4065e+05 8.9098e+05
  2 2.1724e+05 5.8631e+05 3.0255e+05
  3 1.0737e+05 5.1557e+04 3.3918e+04
  4 1.8976e+04 6.2718e+03 2.5647e+03
  5 5.9563e+03 1.0070e+03 1.2966e+03
  6 2.4515e+03 8.1391e+01 4.1498e+01


units:  NA
lot "catch.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2005    2006    2007    2008    2009    2010    2011    2012    2013
  0 0.00424 0.00494 0.00966 0.00479 0.00519 0.00437 0.00543 0.00652 0.00350
  1 0.01323 0.01377 0.01470 0.01266 0.01301 0.01005 0.01301 0.01439 0.01189
  2 0.02062 0.02119 0.02010 0.02307 0.02069 0.02185 0.02479 0.02318 0.02360
  3 0.02972 0.02934 0.02919 0.03028 0.03022 0.02846 0.03789 0.03349 0.03245
  4 0.03862 0.04206 0.03697 0.03900 0.04254 0.03143 0.05142 0.03462 0.03321
  5 0.04584 0.05182 0.04272 0.05090 0.05012 0.03681 0.06563 0.04941 0.04395
  6 0.04356 0.05720 0.04922 0.04125 0.06744 0.06336 0.07317 0.03988 0.06297


units:  NA

Slot "discards.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2005 2006 2007 2008 2009 2010 2011 2012 2013
  0 0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0
  5 0    0    0    0    0    0    0    0    0
  6 0    0    0    0    0    0    0    0    0
Slot "discards.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2005 2006 2007 2008 2009 2010 2011 2012 2013
  0 0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0
```

```
  3 0   0   0   0   0   0   0   0   0
  4 0   0   0   0   0   0   0   0   0
  5 0   0   0   0   0   0   0   0   0
  6 0   0   0   0   0   0   0   0   0

units:  NA

Slot "landings":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   2005  2006  2007  2008  2009  2010  2011  2012  2013
  all 17602 13625 17886 20843 16489 13406 18559 24931 20214

units:  NA

Slot "landings.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2005      2006      2007      2008      2009      2010      2011
  0  24623.80   7149.72    596.93   6678.34   3910.73  28029.16  29325.47
  1 446026.45 289385.03 633607.85 189996.56 395249.71 300248.16 715934.21
  2 510230.84 381781.75 364748.18 556876.10 421199.27 334444.56 272264.80
  3 117165.34  68877.62  61099.75 232242.60  92146.01 128585.37 134564.13
  4  15977.08  19612.53   5731.81  27287.17  37179.53  55875.04  23781.85
  5   2078.61   2295.04   2740.42   2573.87   6013.34  18165.19   7464.85
  6     54.25    554.51      1.00     26.65    998.35   6057.42   3072.33
   year
age 2012      2013
  0  20740.43 380709.31
  1 692427.99 961880.30
  2 633694.93 326623.76
  3  55724.15  36617.10
  4   6778.74   2768.80
  5   1088.40   1399.80
  6     87.97     44.80

units:  NA

Slot "landings.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2005    2006    2007    2008    2009    2010    2011    2012    2013
  0 0.00424 0.00494 0.00966 0.00479 0.00519 0.00437 0.00543 0.00652 0.00350
```

```
  1 0.01323 0.01377 0.01470 0.01266 0.01301 0.01005 0.01301 0.01439 0.01189
  2 0.02062 0.02119 0.02010 0.02307 0.02069 0.02185 0.02479 0.02318 0.02360
  3 0.02972 0.02934 0.02919 0.03028 0.03022 0.02846 0.03789 0.03349 0.03245
  4 0.03862 0.04206 0.03697 0.03900 0.04254 0.03143 0.05142 0.03462 0.03321
  5 0.04584 0.05182 0.04272 0.05090 0.05012 0.03681 0.06563 0.04941 0.04395
  6 0.04356 0.05720 0.04922 0.04125 0.06744 0.06336 0.07317 0.03988 0.06297

units:  NA

Slot "stock":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   2005 2006 2007 2008 2009 2010 2011 2012 2013
  all NA   NA   NA   NA   NA   NA   NA   NA   NA

units:  NA * NA

Slot "stock.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique
  year
age 2005       2006       2007       2008       2009       2010
  0 2.6413e+06 3.1083e+06 1.8605e+06 1.8521e+06 1.2553e+06 2.8123e+06
  1 1.4033e+06 1.7534e+06 2.0783e+06 1.2467e+06 1.2366e+06 8.3864e+05
  2 6.7078e+05 6.3046e+05 9.6165e+05 8.9864e+05 6.9778e+05 5.4224e+05
  3 1.6611e+05 9.4804e+04 1.4068e+05 3.5995e+05 1.9822e+05 1.6222e+05
  4 2.1480e+04 2.9866e+04 1.2686e+04 4.6618e+04 7.2732e+04 6.6036e+04
  5 2.8287e+03 3.2871e+03 5.5368e+03 4.0306e+03 1.1445e+04 2.1786e+04
  6 7.0068e+01 7.5315e+02 1.9516e+00 3.9919e+01 1.8366e+03 6.8538e+03
   year
age 2011       2012       2013
  0 2.1822e+06 3.1559e+06 5.5559e+06
  1 1.8669e+06 1.4436e+06 2.0998e+06
  2 3.6735e+05 7.8375e+05 4.4315e+05
  3 1.4648e+05 6.8376e+04 4.5336e+04
  4 2.5309e+04 1.0279e+04 3.6223e+03
  5 8.0116e+03 1.4289e+03 1.7553e+03
  6 3.0503e+03 1.0798e+02 5.2049e+01

units:  NA

Slot "stock.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2005    2006    2007    2008    2009    2010    2011    2012    2013
```

```
  0 0.00424 0.00494 0.00966 0.00479 0.00519 0.00437 0.00543 0.00652 0.00345
  1 0.01323 0.01377 0.01470 0.01266 0.01301 0.01005 0.01301 0.01439 0.01146
  2 0.02062 0.02119 0.02010 0.02307 0.02069 0.02185 0.02479 0.02318 0.02272
  3 0.02972 0.02934 0.02919 0.03028 0.03022 0.02846 0.03789 0.03349 0.02899
  4 0.03862 0.04206 0.03697 0.03900 0.04254 0.03143 0.05142 0.03462 0.03465
  5 0.04584 0.05182 0.04272 0.05090 0.05012 0.03681 0.06563 0.04941 0.04753
  6 0.04356 0.05720 0.04922 0.04125 0.06744 0.06336 0.07317 0.03988 0.19701

units:  NA

Slot "m":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2005 2006 2007 2008 2009 2010 2011 2012 2013
  0 0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4
  1 0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4
  2 0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4
  3 0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4
  4 0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4
  5 0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4
  6 0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4

units:  NA

Slot "mat":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2005 2006 2007 2008 2009 2010 2011 2012 2013
  0 0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
  1 0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8  0.8
  2 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  3 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  4 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  5 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  6 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0

1 0.40011322 0.20066857 0.43842462 0.18033155 0.42442586 0.42547578
  2 1.55662658 1.09994491 0.58268120 1.11148998 1.05894366 0.90884221
  3 1.31593393 1.61129380 0.70451733 1.19918473 0.69919655 1.45779858
  4 1.47708240 1.28530906 0.74661325 1.00440528 0.80551344 1.70931154
  5 1.43701914 1.46599688 0.85862740 1.17569234 0.84053364 1.64543042
  6 1.43701914 1.46599688 0.85862740 1.17569234 0.84053364 1.64543042
   year
age 2011       2012       2013
  0 0.01318364 0.00745433 0.08069511
```

```
  1 0.46797156 0.78098539 0.73035919
  2 1.28128983 2.44998213 1.79507412
  3 2.25676385 2.53789590 2.45088459
  4 2.47425488 1.36745084 2.00086019
  5 2.38672791 1.97169070 2.32501896
  6 2.38672791 1.97169070 2.32501896

units:  f

Slot "harvest.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2005 2006 2007 2008 2009 2010 2011 2012 2013
  0 0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0
  5 0    0    0    0    0    0    0    0    0
  6 0    0    0    0    0    0    0    0    0

units:  NA
Slot "m.spwn":
An object of class "FLQuant"
, unit = unique, season = all, area = unique

   year
age 2005 2006 2007 2008 2009 2010 2011 2012 2013
  0 0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0
  5 0    0    0    0    0    0    0    0    0
  6 0    0    0    0    0    0    0    0    0

units:  NA

Slot "name":
[1] "BLACK SEA MACKEREL, 2013, COMBSEX, PLUSGROUP,INDEX FILE"

Slot "desc":
[1] "Imported from a VPA file. (HMA_04_2013IND.DAT.txt).  Fri Oct 10 16:18:15 2014 + FLAssess: "

Slot "range":
      min       max plusgroup   minyear   maxyear   minfbar   maxfbar
        0         6         6      2005      2013         1         4
```

FLIndex is reproduced below:

```
An object of class "FLIndex"
Slot "type":
[1] "numbers"

Slot "distribution":
character(0)

Slot "index":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2004       2005       2006       2007       2008       2009
  0    5.75032    9.50192    3.82109    0.13025    3.44039    2.37478
  1   16.71216  526.52350  402.20831 1337.11974  264.51233  711.84123
  2   56.70292  932.52329  896.45309 1054.30230 1428.75914 1200.63353
  3 1571.74040  305.13672  199.77451  233.29080  795.58289  340.88253
  4    0.00100   50.31652   91.03994   24.87802  115.92992  187.07386
  5    0.00100    8.21789   12.70615    7.13864   12.08784   33.30147
  6    0.00100    0.00100    3.54465    0.00100    0.00100    9.04885
   year
age 2010       2011       2012       2013
  0   14.07393   13.98811    4.86890  168.11478
  1  351.14060  913.57738 1268.24535 1310.86009
  2  848.59199  662.27123 1811.31918  845.35540
  3  417.37934  497.82814  199.51021   77.95181
  4  181.88313  116.34814   13.32317    4.35134
  5   65.92909   48.61743    5.38512    1.91987
  6   44.96025   22.49778    0.00100    0.00100

units:  NA


Slot "catch.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2004       2005       2006       2007       2008       2009
  0    5.75032    9.50192    3.82109    0.13025    3.44039    2.37478
  1   16.71216  526.52350  402.20831 1337.11974  264.51233  711.84123
  2   56.70292  932.52329  896.45309 1054.30230 1428.75914 1200.63353
  3 1571.74040  305.13672  199.77451  233.29080  795.58289  340.88253
  4    0.00100   50.31652   91.03994   24.87802  115.92992  187.07386
  5    0.00100    8.21789   12.70615    7.13864   12.08784   33.30147
  6    0.00100    0.00100    3.54465    0.00100    0.00100    9.04885
   year
```

```
age 2010      2011      2012      2013
  0   14.07393   13.98811    4.86890  168.11478
  1  351.14060  913.57738 1268.24535 1310.86009
  2  848.59199  662.27123 1811.31918  845.35540
  3  417.37934  497.82814  199.51021   77.95181
  4  181.88313  116.34814   13.32317    4.35134
  5   65.92909   48.61743    5.38512    1.91987
  6   44.96025   22.49778    0.00100    0.00100

units:  NA


Slot "effort":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
  all 1    1    1    1    1    1    1    1    1    1

units:  NA


Slot "name":
[1] "Commercial CPUE Turkey"

Slot "desc":
[1] "Tuning Horse Mackerel in Black Sea, 2013, COMBSEX . Imported from VPA file."

Slot "range":
      min       max plus group   midyear   maxyear    startf      endf
      0.0       6.0       6.0    2004.0    2013.0       0.5       0.5


Slot "names":
[1] "Commercial CPUE Turkey"

Slot "desc":
[1] "Tuning Horse Mackerel in Black Sea, 2013, COMBSEX . Imported from VPA file."

Slot "lock":
[1] FALSE
```

6.4.5.4 Results

Different XSAs where run with varying settings for the shrinkage in the fishing mortality standard error for 2 and 3 years as follows in R code:

FLXSA.control.hma <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=0.5,rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=2, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)
FLXSA.control.hma1 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1.0, rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=2, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)
FLXSA.control.hma2 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2.0, rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=2, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)
FLXSA.control.hma3 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=0.5,rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=3, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)
FLXSA.control.hma5 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2.0, rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=3, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)
FLXSA.control.hma6 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=0, rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=3, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)

STECF EWG 14-14 accomplished analysis of residuals of Turkish tuning series for different shrinkage settings, results are presented in Figs. 6.4.5.4.1 - 6.4.5.4.2.

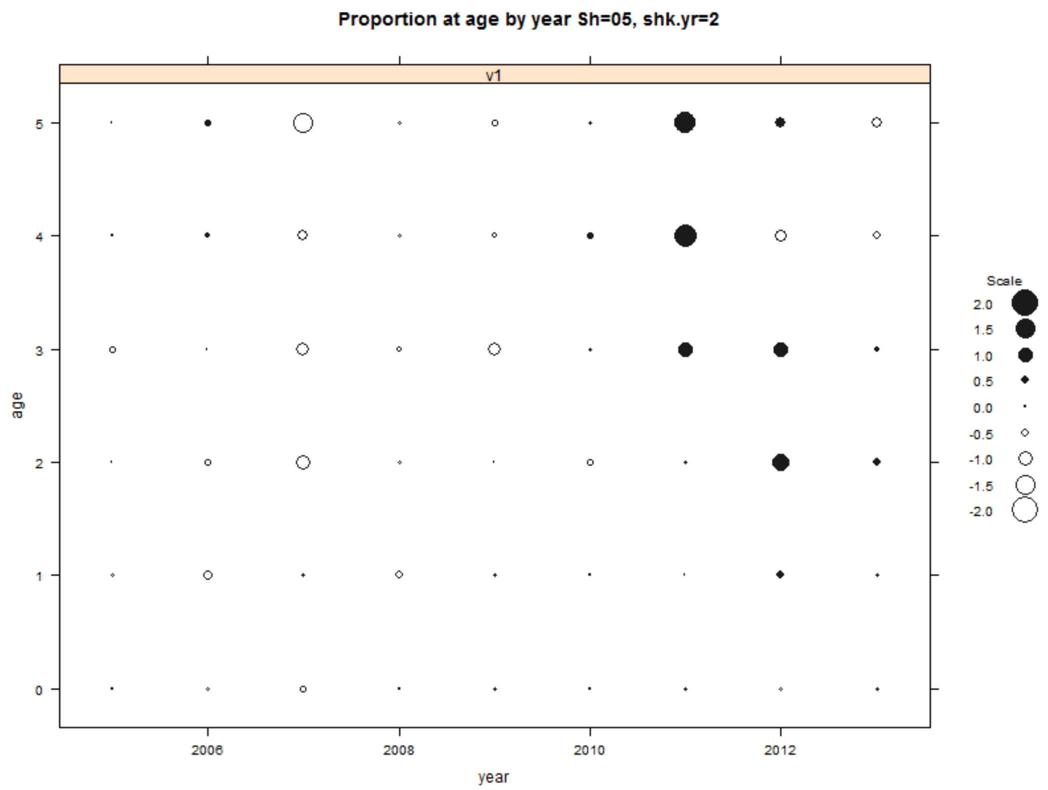


Figure 6.4.5.4.1 Residuals of tuning series applying a shrinkage of 0.5.

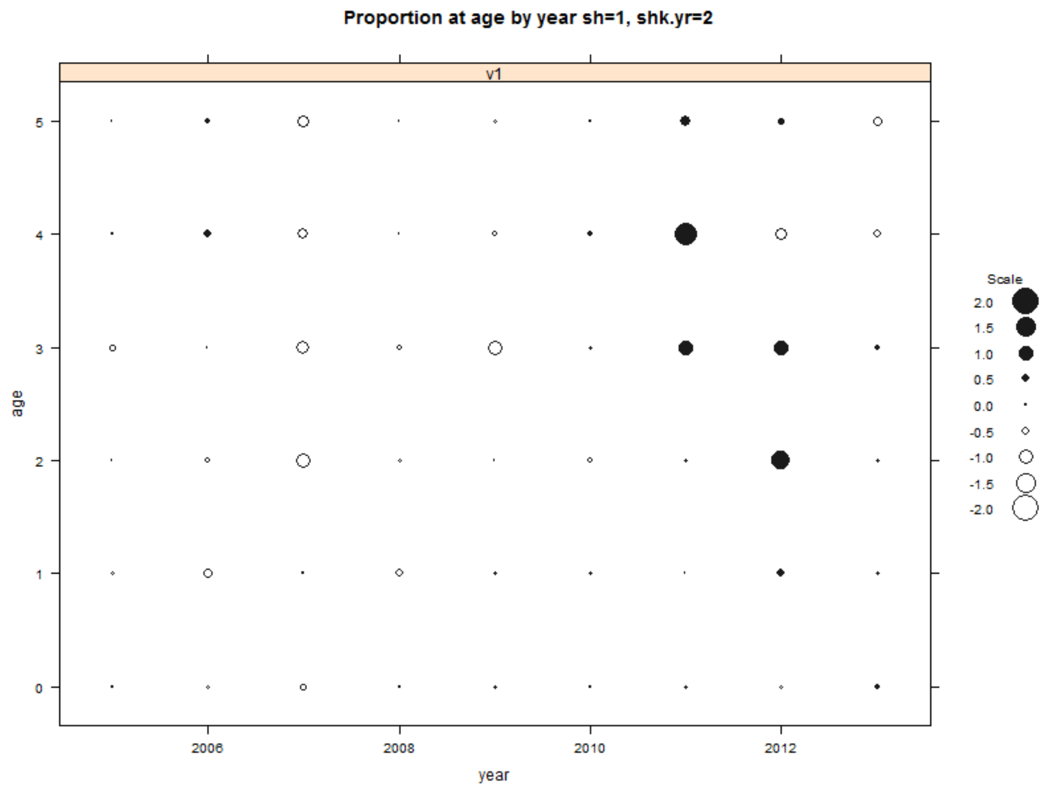


Figure 6.4.5.4.2 Residuals of tuning series applying a shrinkage of 1.0.

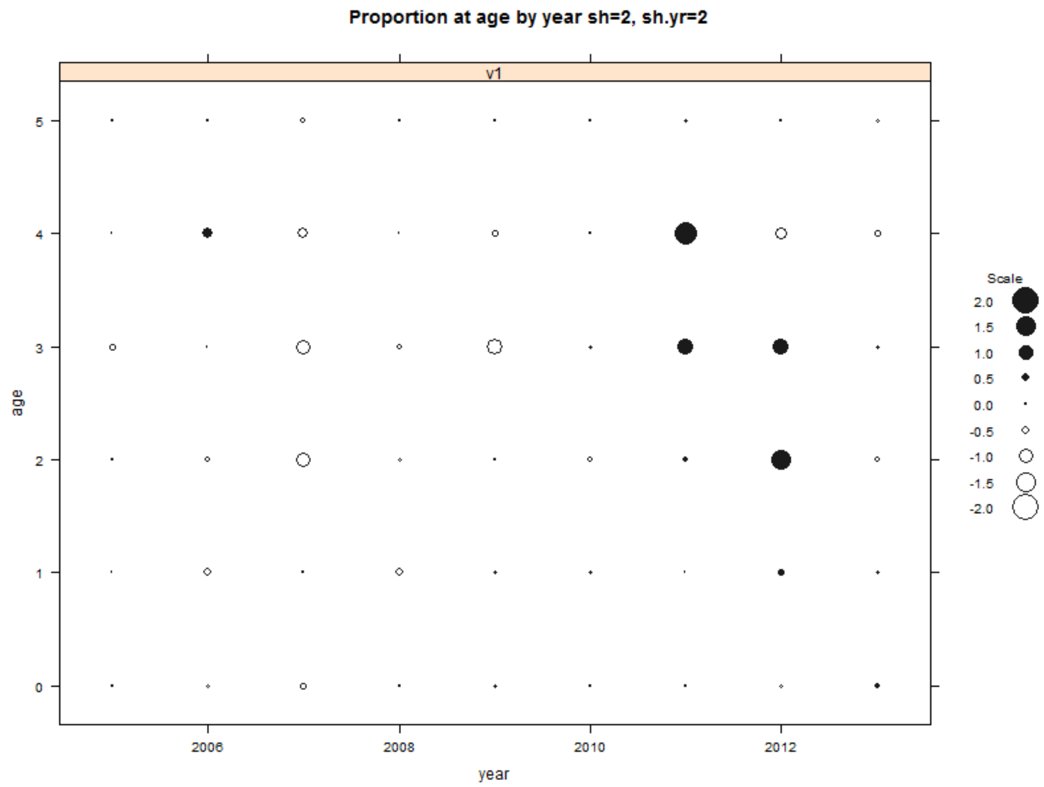


Figure 6.4.5.4.3. Residuals of tuning series applying a shrinkage of 2.0.

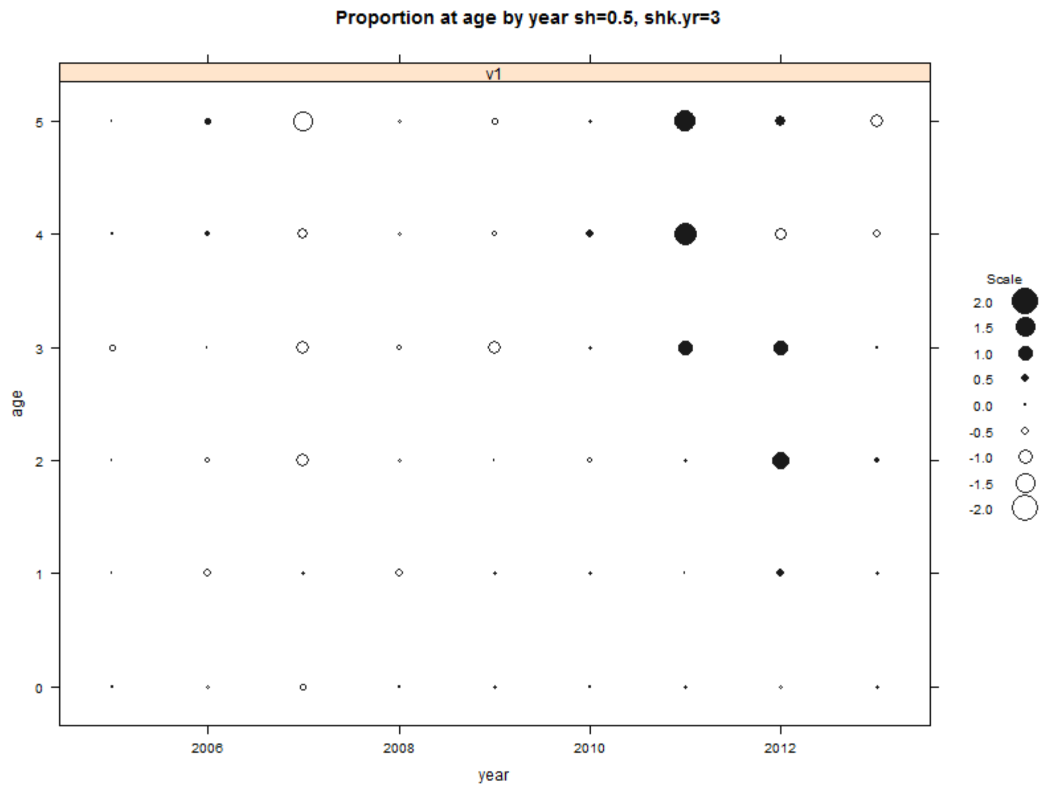


Fig. 6.4.5.4.4. Residuals of tuning series applying a shrinkage of 0.5.

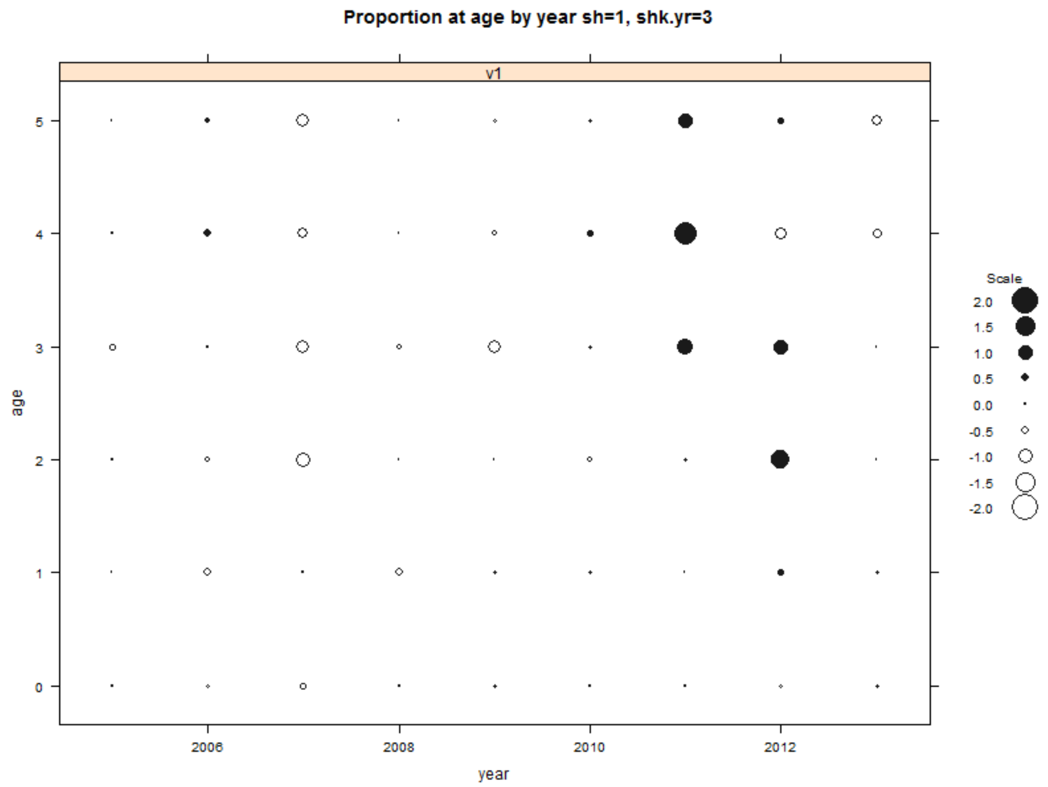


Fig. 6.4.5.4.5. Residuals of tuning series applying a shrinkage of 1.

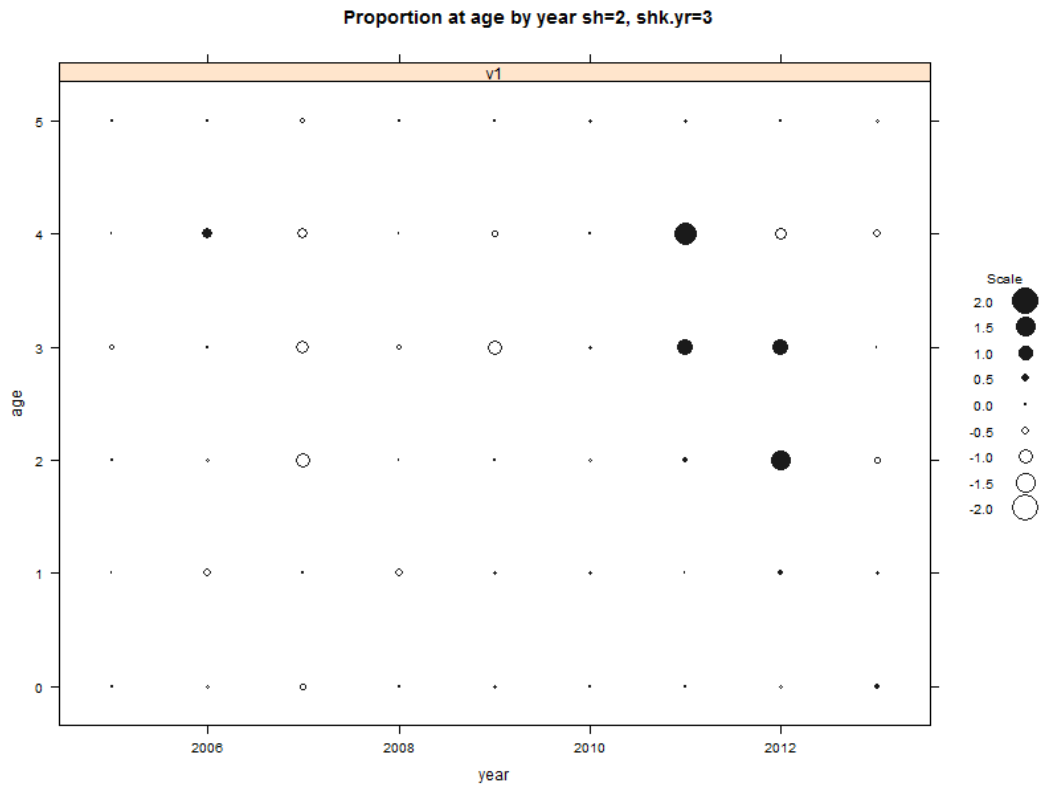


Fig. 6.4.5.4.6. Residuals of tuning series applying a shrinkage of 2.0.

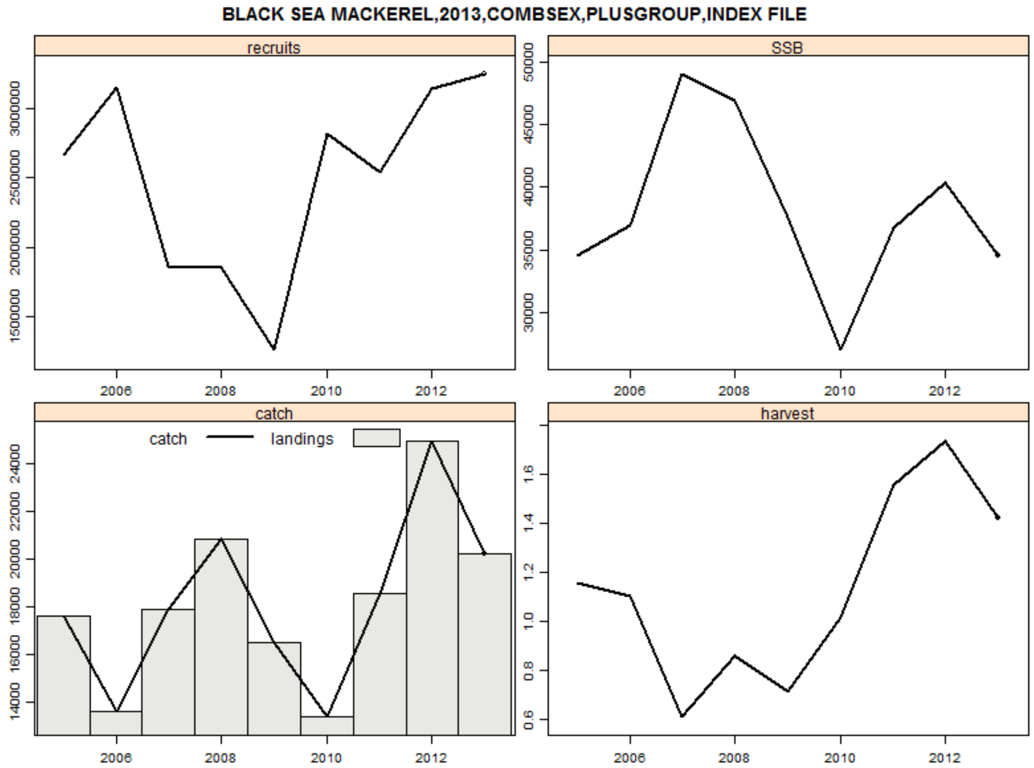


Fig. 6.4.5.4.7. Summary of trends in stock parameters of Horse mackerel in the Black Sea.
XSA diagnostics for best model run with shk.yrs=3, shk.ages=2 are summarized below:

FLR XSA Diagnostics

CPUE data from indices

Catch data for 9 years 2005 to 2013. Ages 0 to 6.

	fleet	first age	last age	first year	last year	alpha	beta
1	Commercial CPUE Turkey	0	5	2005	2013	<NA>	<NA>

Time series weights:

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis:

Catchability independent of size for ages > 1
Catchability independent of age for ages > 5
Terminal population estimation:
Survivor estimates shrunk towards the mean F
of the final 3 years or the 2 oldest ages.
S.E. of the mean to which the estimates are shrunk = 2
Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age \ year	2005	2006	2007	2008	2009	2010	2011	2012	2013
all	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age \ year	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.010	0.003	0.000	0.004	0.003	0.010	0.011	0.007	0.142
1	0.401	0.199	0.431	0.180	0.425	0.425	0.466	0.624	0.735
2	1.553	1.104	0.575	1.071	1.055	0.909	1.281	2.401	0.942
3	1.374	1.594	0.711	1.161	0.641	1.437	2.262	2.539	2.009
4	1.303	1.525	0.723	1.027	0.742	1.297	2.222	1.385	2.006
5	1.172	0.942	1.568	1.082	0.889	1.261	0.762	1.053	2.568
6	1.172	0.942	1.568	1.082	0.889	1.261	0.762	1.053	2.568

XSA population number (Thousand)

year \ age	0	1	2	3	4	5	6
2005	2661622	1401321	671391	162759	22757	3125	78
2006	3149912	1767015	629150	95214	27619	4143	964
2007	1863902	2106170	970768	139804	12961	4031	1
2008	1851759	1248945	917319	366063	46029	4215	42

2009 1255322 1236424 699302 210743 76829 11050 1770
2010 2820623 838631 542110 163244 74428 24532 7805
2011 2543753 1872534 367340 146388 25995 13637 5438
2012 3142292 1685971 787493 68371 10219 1889 147
2013 3244748 2090630 605623 47846 3619 1715 51

Estimated population abundance at 1st Jan 2014

year	0	1	2	3	4	5	6
2014	1	1885994	671794	158176	4297	325	87

Fleet: Commercial CPUE Turkey

Log catchability residuals.

age	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.011	-0.119	-0.259	0.029	0.111	0.028	0.058	-0.097	0.209
1	-0.058	-0.354	0.064	-0.306	0.147	0.110	-0.007	0.223	0.122
2	0.054	-0.145	-0.681	-0.073	0.016	-0.149	0.178	0.982	-0.247
3	-0.222	0.000	-0.670	-0.181	-0.736	0.120	0.817	0.803	-0.045
4	-0.044	0.466	-0.475	-0.052	-0.228	0.053	1.121	-0.531	-0.301
5	0.010	0.048	-0.188	0.052	0.004	0.076	0.109	0.031	-0.146

Regression statistics
Ages with q dependent on year class strength
[1] "0.295600127008184" "0.633757028357619" "14.1047510576624"
[4] "9.83647540033347"

Terminal year survivor and F summaries:

,Age 0 Year class =2013

source	scaledWts	survivors	yrcls
Commercial CPUE Turkey	0.170	3826061	2013
fshk	0.019	30089465	2013
nshk	0.811	1523300	2013

,Age 1 Year class =2012

source	scaledWts	survivors	yrcls
Commercial CPUE Turkey	0.928	814612	2012
fshk	0.072	1084291	2012

,Age 2 Year class =2011

source

	scaledWts	survivors	yrcls
Commercial CPUE Turkey	0.873	123613	2011
fshk	0.127	64761	2011

,Age 3 Year class =2010

source

	scaledWts	survivors	yrcls
Commercial CPUE Turkey	0.607	4112	2010
fshk	0.393	3699	2010

,Age 4 Year class =2009

source

	scaledWts	survivors	yrcls
Commercial CPUE Turkey	0.635	241	2009
fshk	0.365	480	2009

,Age 5 Year class =2008

source

	scaledWts	survivors	yrcls
Commercial CPUE Turkey	0.773	76	2008
fshk	0.227	154	2008

Sensitivity Analysis

EWG 14-14 performed a sensitivity analysis for different shrinkage settings, results are presented in figures 6.4.5.4.8-6.4.5.4.10.

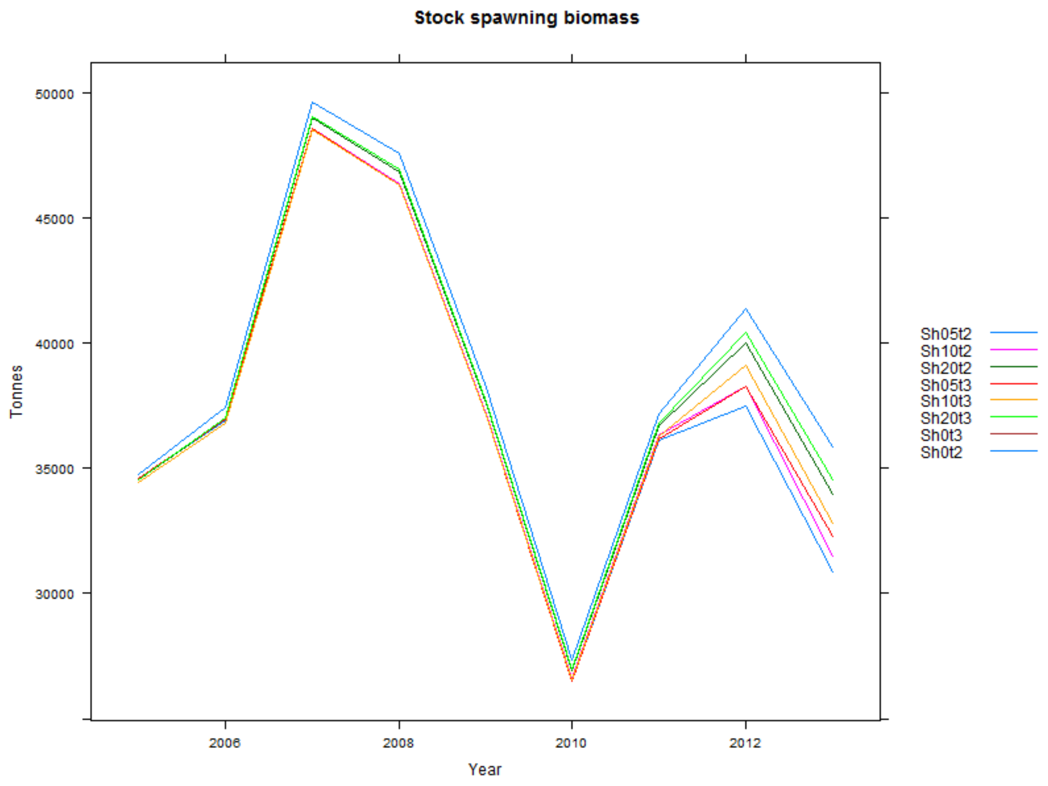


Figure 6.4.5.4.8. Sensitivity analysis on Stock spawning biomass for different levels of shrinkage.

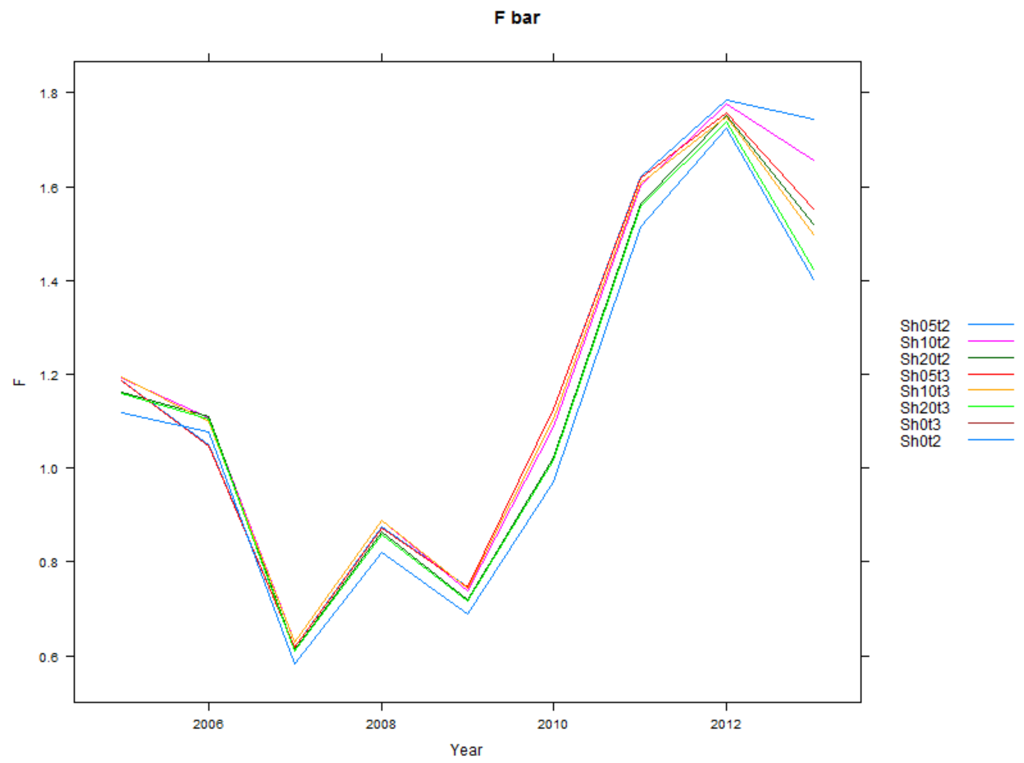


Figure 6.4.5.4.9. Sensitivity analysis on Fbar (Ages 1-3) for different levels of shrinkage.

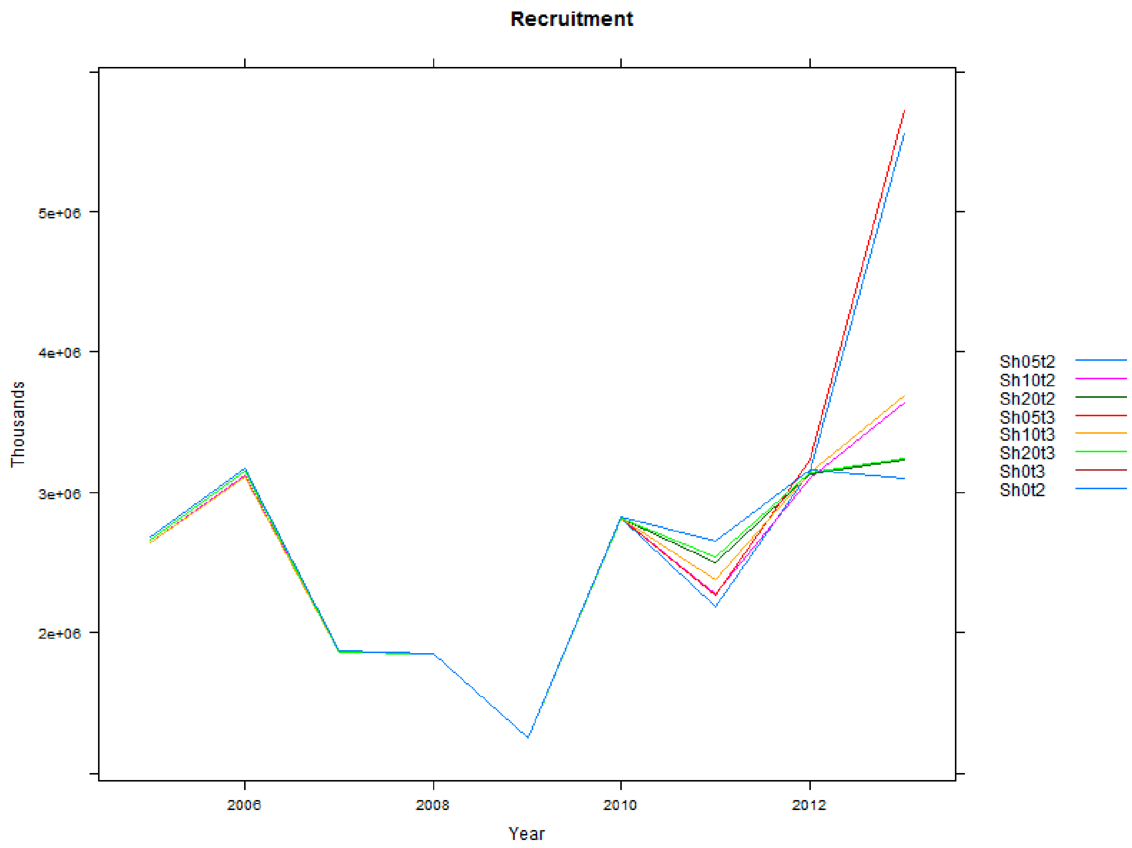


Figure 6.4.5.4.10. Sensitivity analysis on Recruitment for different levels of shrinkage.

Retrospective Analysis

The STECF EWG 14-14 Black Sea applied the Extended Survivors Analysis (XSA) in FLR and the technique "shrinkage to the mean" for assessing the stock of Horse mackerel over the period 2005-2013. The tuning of XSA is defined according to the default settings of the program, results are presented in figures 6.4.5.4.11-6.4.5.4.12.

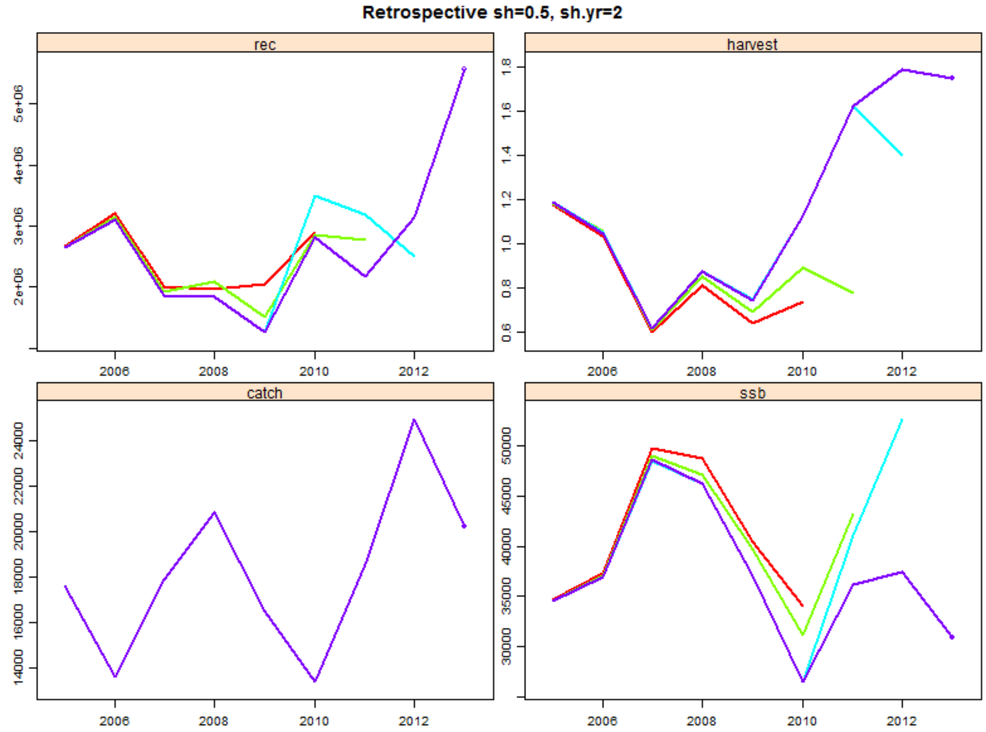


Figure 6.4.5.4.11. Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage 0.5.

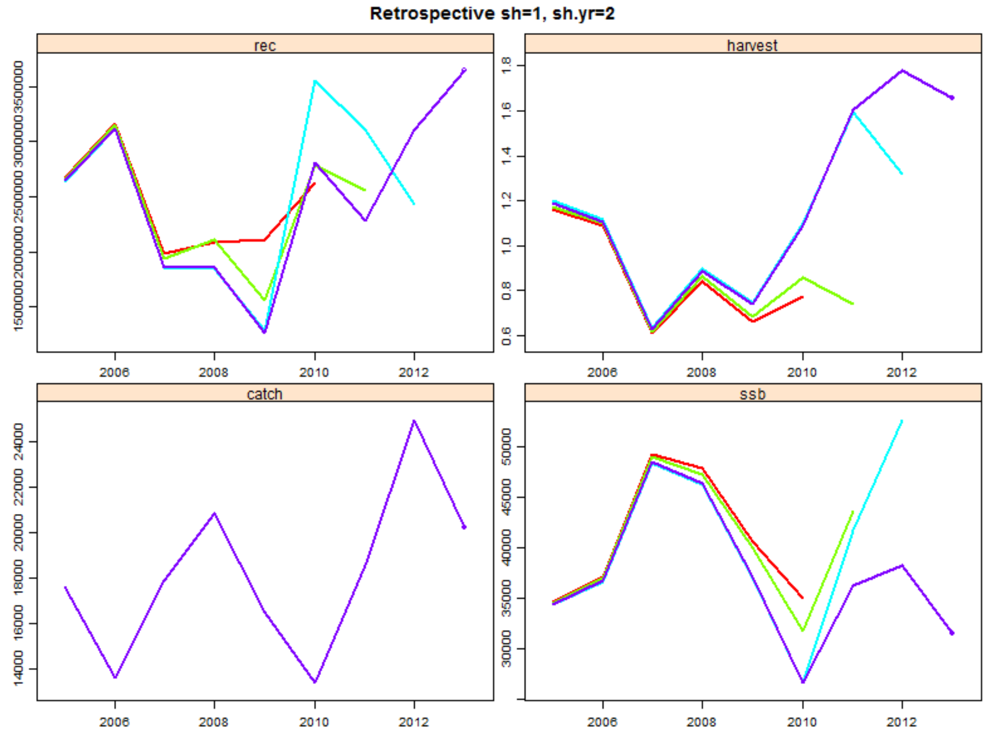


Figure 6.4.5.4.12. Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage 1.

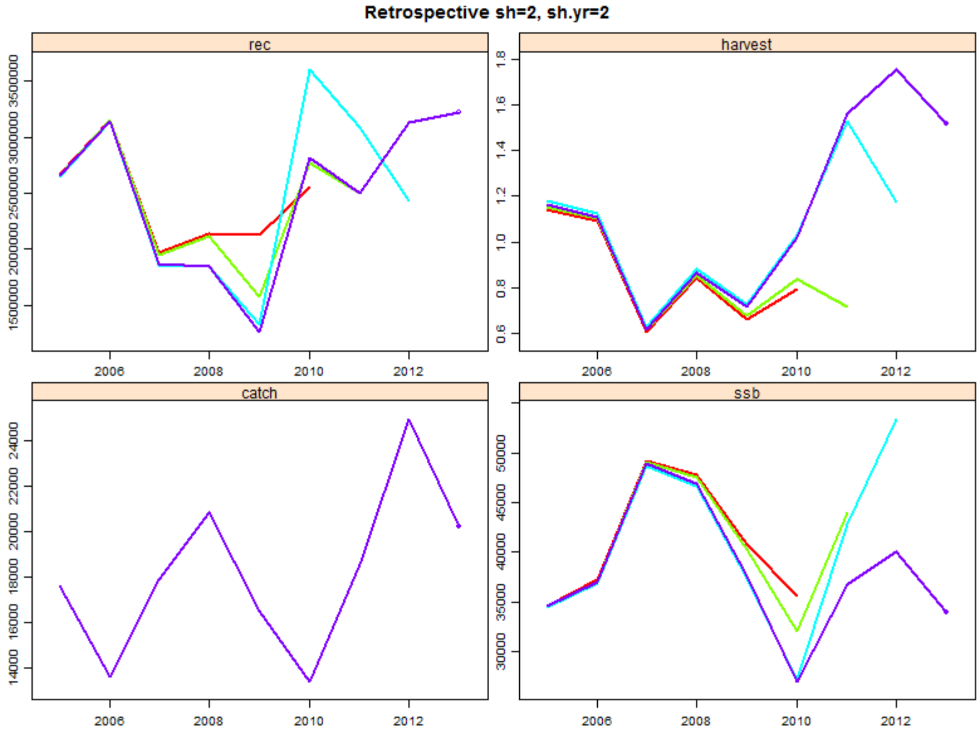


Figure 6.4.5.4.13. Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage 2.

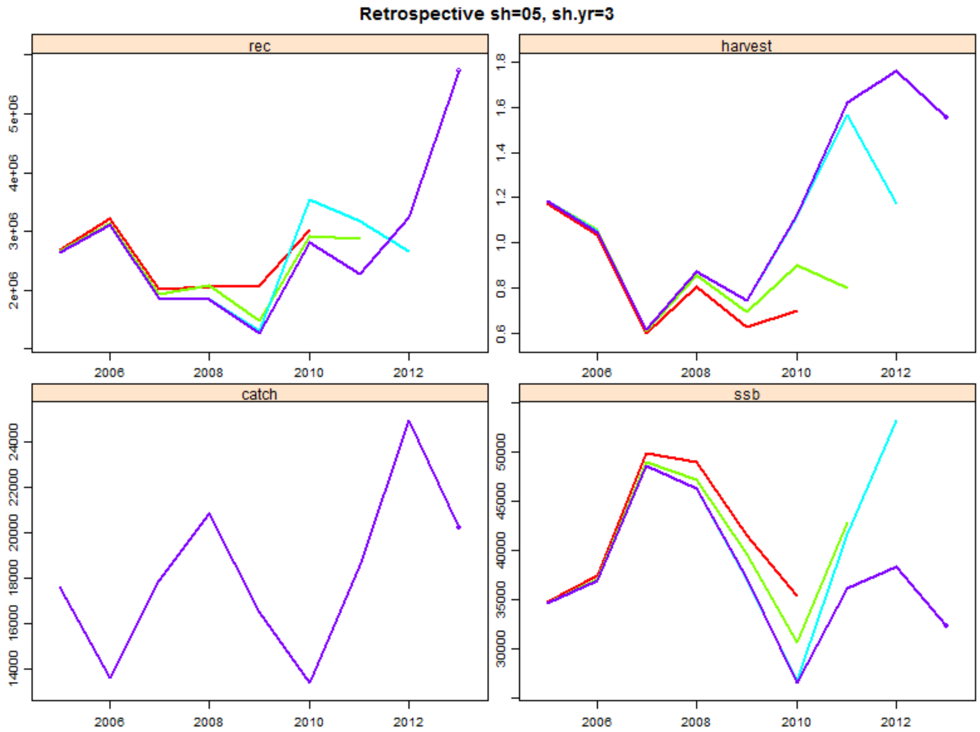


Figure 6.4.5.4.14. Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage 0.5.

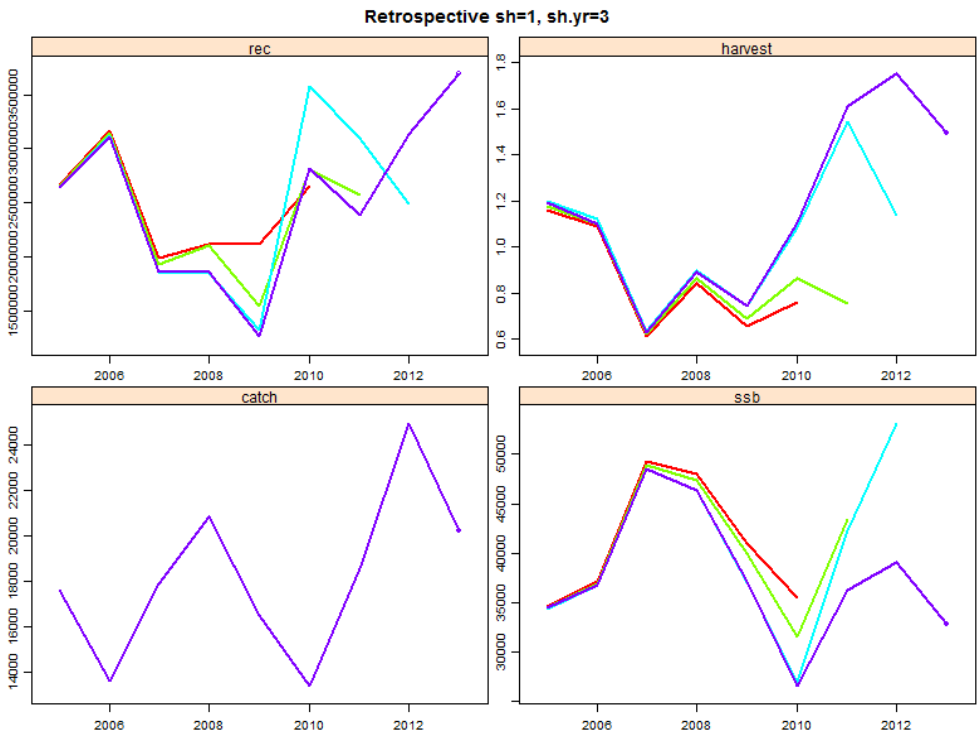


Figure 6.4.5.4.15. Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage 1.

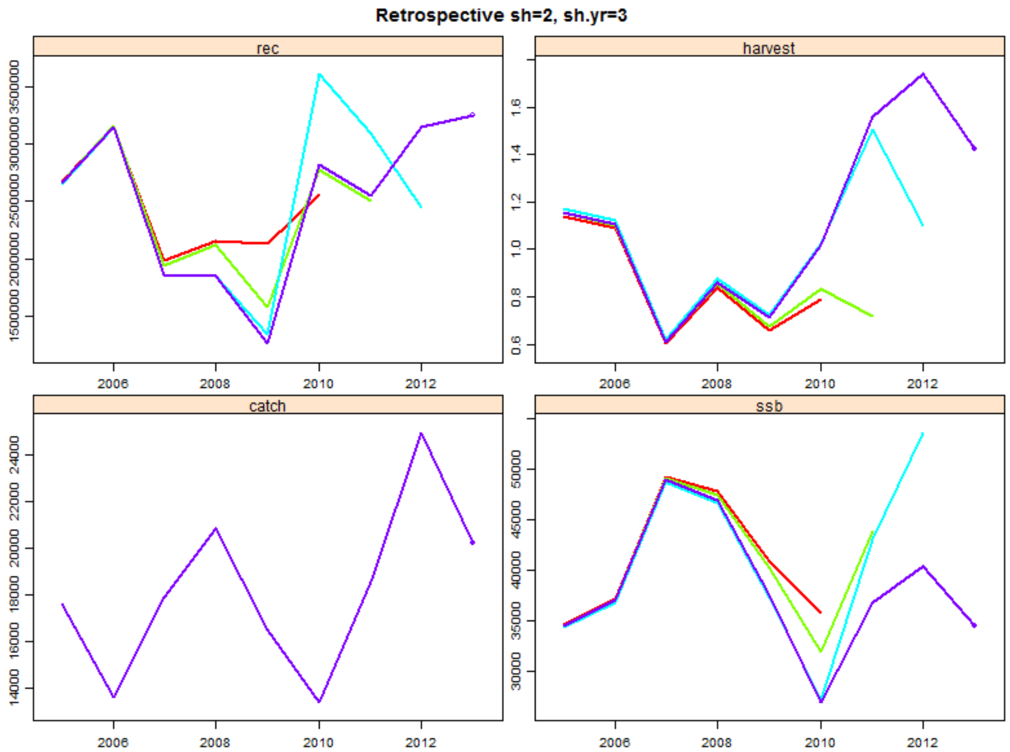


Figure 6.4.5.4.16. Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage 2.

Based on the residual patterns and the retrospective analysis the best assessment was deemed the hma.xsa5, which has a 3 years of shrinkage on 2 ages and a standard error of 2 (Figure 6.4.5.4.17).

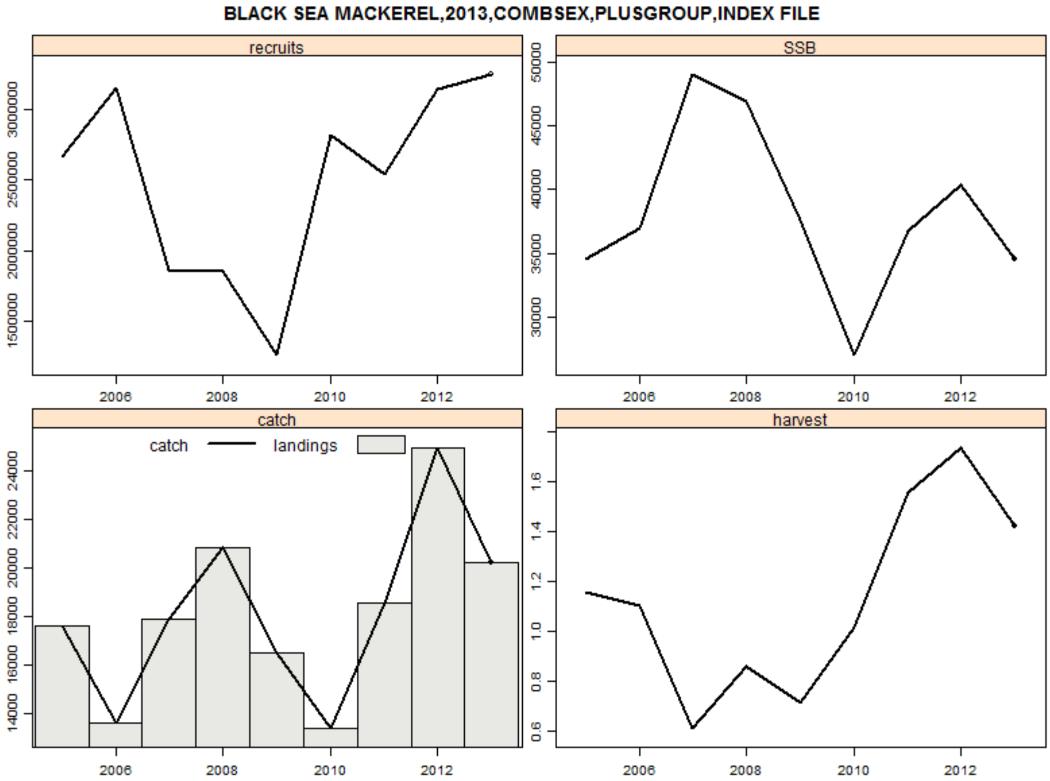


Figure 6.4.5.4.17. Final assessments for Horse Mackerel in the Black Sea according to the XSA best model run (hma.stk5).

Assessment results are reported in Table 6.5.4.1

Table 6.4.5.4.1 Results of the best assessments Spawning Stock Biomass (SSB), F over age 1-4 (F_{bar}), Recruitment (REC), catch and landings.

Year	SSB	F_{bar}	REC	CATCH	LANDINGS
2005	34538.37	1.1577857	2661622	17602.40	17602.40
2006	37022.25	1.1054564	3149912	13625.33	13625.33
2007	49013.28	0.6102013	1863902	17886.08	17886.08
2008	46907.62	0.8597044	1851759	20842.85	20842.85
2009	37647.47	0.7154386	1255322	16489.06	16489.06
2010	26970.41	1.0172681	2820623	13405.50	13405.50
2011	36771.91	1.5578679	2543753	18558.87	18558.87
2012	40405.69	1.7370362	3142292	24931.36	24931.36
2013	34530.60	1.4231011	3244748	20213.51	20213.51

The EWG14-14 endorses the stock assessment for horse mackerel given the improvement over previous year's assessments. The main reason for accepting the current XSA assessments is the availability this year of a tuning fleet from commercial CPUE from Turkey that is considered reliable and is deemed appropriate for tuning the bulk of the catches coming from the Turkish series. There are however two limitations with this CPUE: first, the CPUE is an index of biomass split with the age structure of the catch matrix from Turkey; second, the yearly biomass index is derived by summing the monthly CPUEs rather than averaging across months. Finally a commercial CPUE derived from purse-seine and standardized to kg/vessel/day is a very raw index since it does not account of search time, number of sets, boat size etc. A much better index should be derived from fisheries independent surveys. Thus an international hydro-acoustic survey should be established to monitor trends in the horse mackerel age-structure and stock biomass across all national waters of the Black Sea.

6.4.6 Short term prediction of stock biomass and catch

Given the limitations, described above, with the Turkish CPUE used to tune the assessment, the EWG 14 14 did not undertake a short term prediction of stock size and biomass under various management scenarios.

6.4.7 Medium term prediction of stock biomass and catch

Given the limitations, described above, with the Turkish CPUE used to tune the assessment the EWG 1414 did not undertake a medium term prediction of stock size and biomass under various management scenarios.

6.4.8 Long term predictions

Given the limitations, described above, with the Turkish CPUE used to tune the assessment,, the EWG 14 14 did not undertake a long term prediction of stock size and biomass under various management scenarios

6.4.9 Scientific advice

Assessment formulations indicate that the SSB in 2013 is decreasing from previous year, but is fluctuating since 2005. In the absence of total stock size estimates and biological reference points, EWG 14-14 is unable to fully evaluate the stock size with regard to the precautionary approach.

State of recruitment:

Recruitment is indicated to have decrease in the mid part of the series and is now in a high period.

State of exploitation:

Given the current assessment of horse mackerel in the Black Sea, F_{2013}= 1.42310. Since the stock is pelagic as reference point the Patterson Exploitation E=0.4 was selected to be consistent with long term exploitation of the stock. The E_{2013}= 0.7805936 is almost two times higher than the reference point, thus the stock is in state of overexploitation in 2013 and since 2005 (Figure 6.4.9.1).

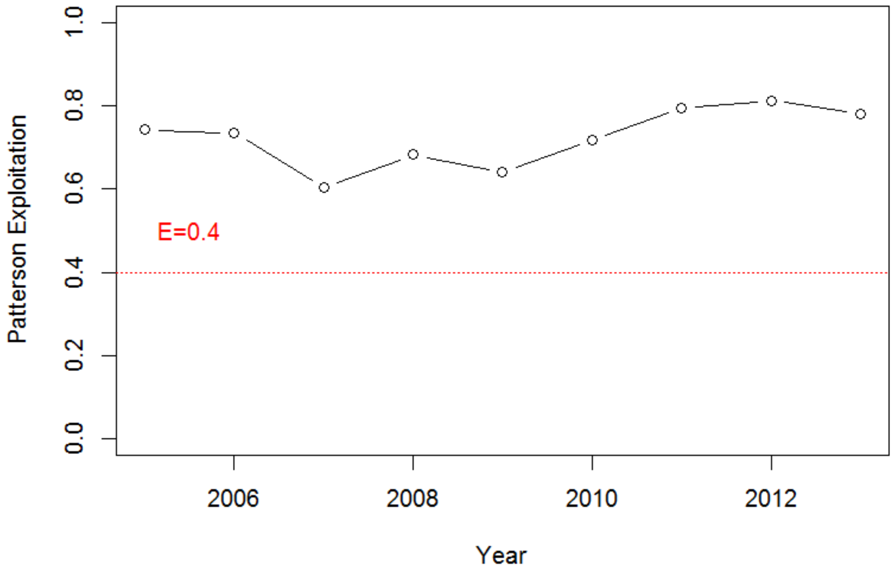


Figure 6.4.9.1. Patterson Exploitation of Horse mackerel in relation to reference point E=0.4.

6.4.9.1 Medium term considerations

Given the current state of the assessment of horse mackerel in the Black Sea, EWG 14-14 is unable to provide advice for the medium term future.

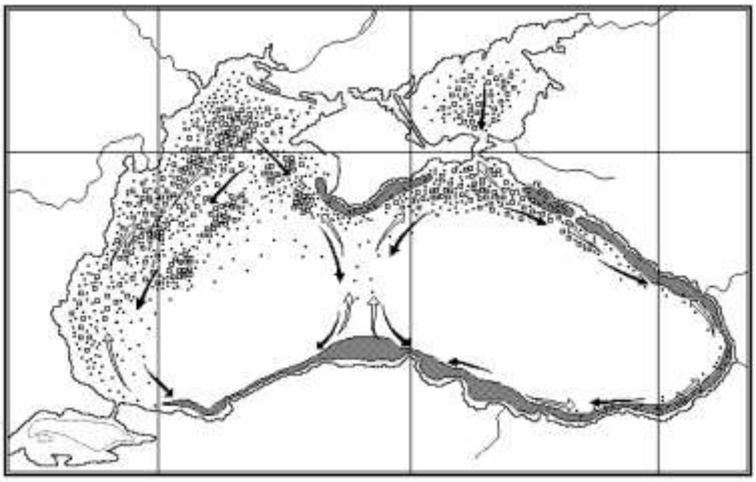
6.5 ANCHOVY IN GSA 29

6.5.1 Biological features

6.5.1.1 Stock identification

There are two subspecies of anchovy in the Black Sea: the Black Sea anchovy, *Engraulis encrasicolus ponticus* and the Azov Sea anchovy, *Engraulis encrasicolus maeticus* (Ivanova et al., 2013); each forming isolated stocks (Ivanov and Beverton 1985). The later reproduces and feeds in the Azov Sea and hibernates along the northern Caucasian and Crimean coast of the Black Sea. In addition to these two distinct stocks, there are strong evidences for the existence of a resident stock, spawning within the Turkish EEZ and overwintering on the Anatolian coast. An alternative view to existence of more than two stocks is displacement in the spawning areas (Niermann et al. 1994). The degradation of ecological status of the spawning area was believed to lead anchovy to replace its spawning areas. The common belief is that the Black Sea anchovy migrates to the wintering grounds along the Anatolian and Caucasian coasts in southern Black Sea in October-November (Ivanov and Beverton, 1985; Chachin 1995). In these areas they form dense hibernating concentrations until March. During this period they are subjected to intensive fishery. In the rest of the year they occupy spawning and feeding habitats across the sea with some preference to the shelf areas characterized by high productivity (Faschuk *et al*. 1995, Daskalov, 1999).

On the other hand in the view of new findings, to what extent the different forms of anchovies are discriminated in the landings and as to whether they subjected to the same nutritious conditions for growth and reproduction and to the same level of natural and fisheries mortality, are matter of assessment concerns. It is crucial to address the question of stock unit for anchovy in the Black Sea. In this assessment it was assumed that *i*) there are only two stocks of anchovy in the Black Sea; ii) the Azov Sea anchovy inhabits a rather small region confined to Sea of Azov, east of Kerch, Caucasian coast and to an extent Georgia; iii) this stock is almost exclusively fished and hence regulated by Ukraine and Russian Federation. Therefore the assessment is populated with the data pertaining only to the Black Sea anchovy.



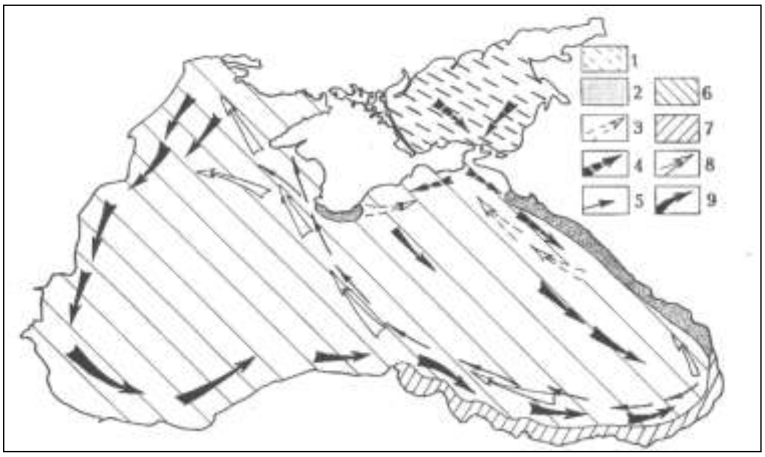


Figure 6.5.1.1.1 The spawning areas and scheme of the anchovy migrations (Upper Ivanov and Beverton, 1985; Lower Chaschin, 1995. The Azov anchovy: 1 — spawning and foraging region; 2 — wintering region; 3 — spring migrations; 4 — autumnal migrations; 5 — periodical migrations of a muigled population. The Black Sea anchovy: 6 — spawning and foraging region; 7 — wintering region; 8 — spring migrations; 9 — autumnal migrations

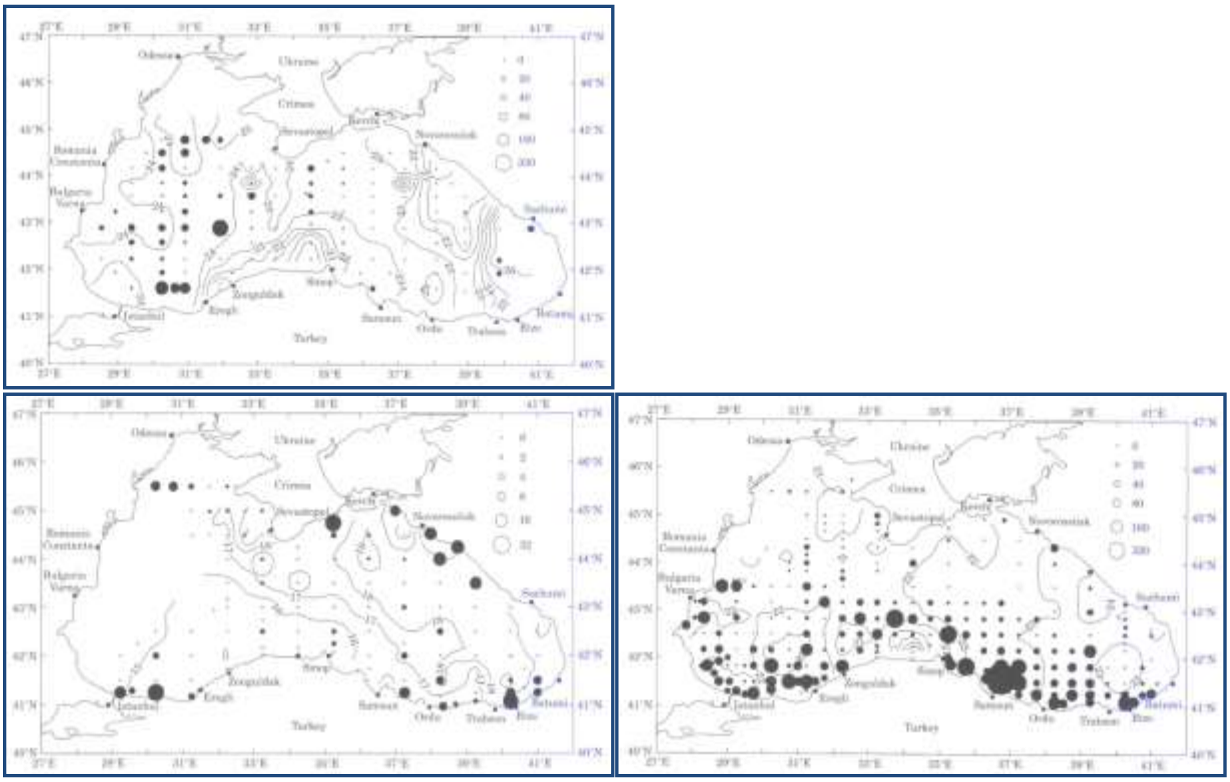


Figure 6.5.1.1.2 Egg distribution of anchovy in 1950s (upper left; Einarson and Gürtürk 1960); and in 1990s (lower, Niermann et al. 1994).

6.5.1.2 Stock structure assumed in the assessment

6.5.1.3 Growth

Anchovy is a short lived species. During the last 30 years, the catch has been represented only by individuals of 0 to 4 years age: the older ages (4 and older) are very rare and not frequently observed in the overwintering areas. The two anchovy forms (Azov and Black Sea) grow differently;

the former growing slower (Chashchin,1996). Therefore it may be worth noting that a growth estimate disregarding stock discrimination would produce results with great variance. The growth estimates reported in the literature are based on mean length of age classes. There are significant differences in mean lengths of the age classes provided by the countries. Fig 6.5.1.3.1 displays the length frequency distributions of Bulgaria, Romania and Turkey. The smallest anchovies were observed in Romanian catch while the largest are in the Bulgarian waters. The overall size range is between 4 and 14.5 cm. In this assessment, the differences were assumed to occur due to differences in the time of sampling; ie. Bulgarian catch represents the summer months when the fishes are about the complete a year cycle; Romanian data displays the size of the anchovies at the time of recruitment; the Turkish data represents the length frequency distribution of anchovies during winter.

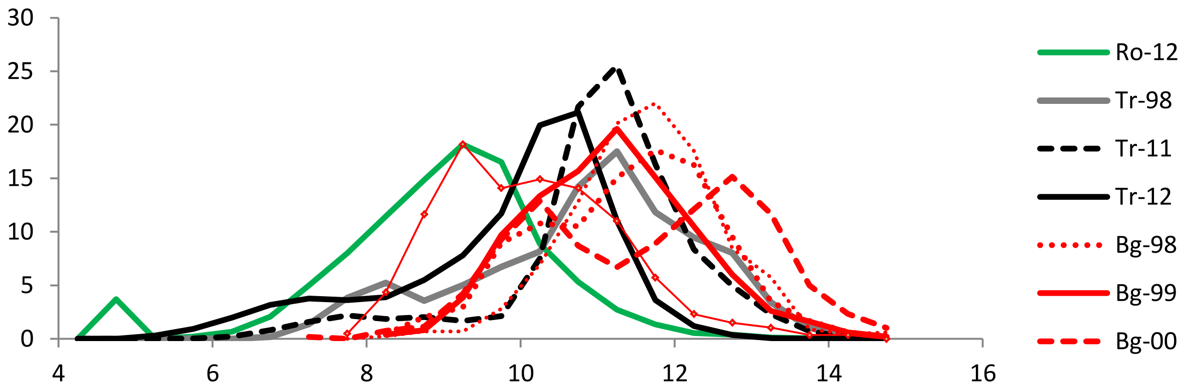


Figure 6.5.1.3.1 Length-frequency distributions reported by countries

Another important point in the anchovy growth is the seasonality. The growth which is very fast during summer, almost ceases during winter. Almost every winter a significant drop in the somatic condition of the overwintering anchovy is reported (Gucu, 2002).

6.5.1.4 Maturity

First maturity age is year 1 for anchovy. It spawns during the summer, the middle of May to the second half of August with a peak from mid-June to the end of July. This period is also the main feeding and growth season. The main feature characterizing the summer habitat is the strong stratification of the water due to the seasonal thermocline and reinforced in coastal and shelf waters by the river plumes. Anchovy was found to spawn mainly in the surface layer of these warm and stratified areas (Arkhipov, 1993; Fashchuk et al. 1995). Eggs and larvae are retained in the coastal layer stabilized in depth by the thermocline and protected from the offshore by thermo-haline fronts. A large convergence zone is formed on the northwestern and the western shelf (the main anchovy spawning area) due to the river Danube inflow, which favors fish offspring retention (Radu and Maximov 2006-2008).

Lisovenko and Andrianov (1996) estimated that a mature anchovy may produce 50 batches and the average number of eggs spawned by one female varies between 138 000 and 231 000 displaying a clear seasonal indeterminate pattern. Interestingly the same authors observed that a small part of each new generation of anchovy reach sexual maturity and spawn two-three months after hatching, at the end of the spawning season. The part of the spawning 0 year class in the population may be as high as 1.5%.

6.5.2 Fisheries

6.5.2.1 General Description

The summer distribution area of the Black Sea anchovy covers entire Black Sea (Figure 6.5.1). However due to disperse spawning distribution the Black Sea stock is not the target of fishery during summer. The winter cooling in the northwest shelf area where the main spawning aggregations were used to found, forces the anchovy migrate south. According to the historical literature (Pusanov (1936) the migration route usually followed the coastlines of Romania, Bulgaria and Turkey. Old records also states that the migrating Black Sea anchovy diverts on the Turkish coast a part entered the Sea of Marmara through the Istanbul strait (Deveciyan, 1915). However more recently, Gordina et al (1997) found smaller, elongated eggs in the southwestern Black Sea. Due to similarities in the egg morphometric, they claimed that the third form of anchovy spawning in the Black Sea might actually be migrated from the Sea of Marmara.

During the winter migration anchovy used to caught by coastal trap nets and beach seines mainly in Bulgaria, Romania however historically it was caught by coast traps along the Istanbul strait too. The main Black Sea anchovy fishery however has been carried out by purse seiners and the fleet targeted the schools over the overwintering ground located on the Turkish and Georgian waters for more than 50 years. During the years between 1960 and 1990 the anchovy catch of the countries located on the migration route has increased gradually and reach to a maxima in the first half of 1980s (Figure 6.5.1). Almost synchronously, the anchovy catch of all Black Sea countries dropped in the second half of the 1980s. The roots of the collapse has been evaluated by various authors and are: fishing pressure; distrophication by Danube River and degradation of the ecosystem on the main feeding and spawning ground; destruction at the lower trophic levels of the Black Sea ecosystem by the intrusion of an alien gelatinous species were some of the factors blamed. Following the three years after the collapse, the Black Sea anchovy stock seemed to recover as can be seen from the increase in the Turkish landings (Figure 6.5.2.3.1.1). However, the catch of the countries on the migration route of the species has never been increased and even reduced. This situation is explained by drastic drop in the number of fishing vessels and pond net in these countries; however it may also be an indication of habitat shift and or change in the migration route.

6.5.2.2 Management regulations applicable in 2012 and 2013

In the Black Sea countries, anchovy fisheries are generally regulated by i) closed seasons (May April to October/November for Bulgaria and Romania, April to September for Turkey, and no closed season for Ukraine), ii) closed areas, iii) mesh size regulations, iv) minimum landing size (9 cm total length in general and 7 cm TL for Georgia). The Black Sea and Azov anchovy are treated as two different stocks in Ukraine and in the Russian Federation and the fishery is managed separately for each stock.

Turkey, having the main fleet fishing the Black Sea anchovy, enforced additional measured to control the size of the fishing fleet. These include:

a) fishing capacity had developed over the years and finally overcapitalized beyond profitability within the last 3 decades. The issue and its consequences on the fish stocks have been recognized in mid-1990s when a significant reduction in the stocks hit the fishing sector. However a comprehensive measure has been enforced only at the beginning of 2000's. As a first step, licensing new fishing boats has been stopped in 2002 with the aim of reducing the fishing pressure on the stocks and to maintain sustainable fisheries. Despite interruptions during 2004 and 2005, the applied policy had positive effects on control of increasing fleet capacity. Since then, new entries to the fleet are only allowed when a vessel of same size is exiting from the fleet. In summary the size of the main anchovy fishing fleet in the Black Sea is stable since 2005.

b) another very substantial and promising remedy is the fishing boat buyback program launched in 2012 and repeated in 2013. Given that by far greater part of the catch is landed by the industrial boats, the first phase of the program targets fishing vessels larger than 12 meters in 2012. Although the ultimate goal is to reach greater percentages in time, with the available funds allocated for the buyback program only 407 boats (156 boats of them were registered to the port on the Black Sea coast) has been removed from the fleet at this first phase in 2013. In the second phase launched in 2014 another 529 boats have been decommissioned within this campaign.

c) a series of new regulations and methodological reforms have been enforced within the last 2 years to enhance accuracy of the landing statistics,

d) as of 18.08.2012 the minimum depth limit allowed for purse seine and for pelagic trawls has been increased from 18 to 24 meters. Considering that the anchovy overwintering on the Anatolian coast are confined to 0 to 100 meters, the regulation has noticeable positive effect on the reduction of fishing pressure on the anchovy stocks.

6.5.2.3 Catches

6.5.2.3.1 Landings

The anchovy landings during the period 1994 – 2013 by countries are presented in section 5.1.5. The data presented under Ukraine belong exclusively to the Black Sea anchovy (Azov anchovy excluded). In 1997-2006, the Ukrainian fleet fished the Black Sea anchovy, not only in their own waters, but also in waters of Georgia. Georgia was not represented by a national expert, however Ms Maia Chkhobadze of the Ministry of Energy and Natural Resources of Georgia kindly provided the official anchovy landings of Georgia in 2013. It was assumed that Russian Federations targets only Azov anchovy and the Black Sea anchovy catch of this country is negligibly low.

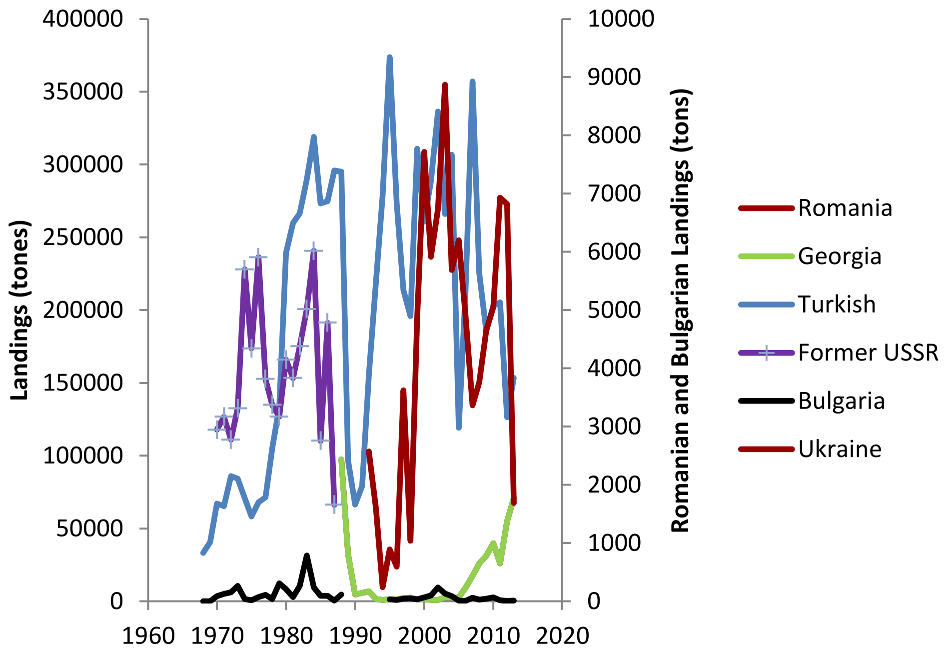


Figure 6.5.2.3.1.1. Annual anchovy landings for the Black Sea countries

6.5.2.3.2 Discards

6.5.2.4 Fishing effort

No data concerning the fishing effort for anchovy were made available for the report for most of the countries; therefore it was not possible to estimate the overall fishing effort for the anchovy fishery in the Black Sea. The only exception is Turkish fleet where both HP (kW) and GT's are available. On the other hand, no correlation was found between engine power or length of anchovy boat and its daily catch. Therefore it was assumed that the number of boats registered for anchovy fishery would sufficiently reflect the fishing effort of the fleet. Number of boats in the Turkish fleet engaged in anchovy fishery is available since 1950s; however as Turkey is not the only country fishing the anchovy in the Black Sea it would not be realistic to use Turkish data only as an index of the overall fishing effort in the Black Sea. Nevertheless following the anchovy collapse in late 1980s Turkey became the main exploiter of the Black Sea anchovy. Almost 95% of the stock has been fished by the Turkish fishermen. Moreover, by a bilateral agreement between two countries the anchovies in Georgian waters are exploited by the Turkish fishing boats. Therefore it is assumed that, the data presented in table 6.5.2.5.1, to a reasonable extent, represents the entire Black Sea.

6.5.2.5 Commercial CPUE

The estimates CPUE by fleets are presented in table 6.5.1

Table 6.5.2.5.1. Effort and CPUE of the commercial fleets

Year/data	Turkish purse seine		Georgian (Turkish) fleet		USSR		USSR[1]	USSR+Ukraine[2]	+Turkish SSB
	Effort	CPUE	effort	CPUE	effort	CPUE	hydroacoustic		
1970	18	3728			147	861			
1971	18	3631			156	710			
1972	24	3579			197	673			
1973	25	3369			174	1312			
1974	29	2441			200	867			
1975	41	1420			165	1433			
1976	53	1283			157	970			
1977	58	1230			154	877			
1978	69	1524			153	830			
1979	78	1714			141	884			
1980	104	2301			162	593		270000	
1981	121	2143			159	926	330000	320000	
1982	145	1838			170	811	325000	150000	
1983	162	1789			126	1312	550000	300000	
1984	171	1865			151	400	270000	190000	
1985	195	1401			141	847	135000	150000	
1986	210	1308			114	857	235000	50000	
1987	229	1292			102	318	350000	100000	
1988	247	1194			102	45	350000	235000	
1989	262	369			103	55	150000	32000	
1990	280	237			101	68		48000	

1991	284	279			100	16		92000	
1992	163	953			101	9			
1993	287	763			101	13			
1994	243	1147			101	12			
1995	262	1427			101	23			
1996	278	983			101	23			
1997	248	862			101	13			
1998	209	938			100	15	190000		
1999	199	1562			100	9	300000		
2000	262	995			100	9	350000		
2001	299	965					380000		
2002	419	803					280000		
2003	500	563	27	99				250000	
2004	443	790	55	47					
2005	565	240	68	38					
2006	502	496	74	125					
2007	528	755	55	317					
2008	589	398	23	1128					
2009	501	384	18	1741					
2010	428	496	19	2098					
2011	400	534	16	1620					306000*
2012	354	373	15	3667					261000*
2013	218	779	21	3367					292000**)

1) Chaschin 2007
2) Chaschin 1998
*Turkish hydroacoustic surveys conducted in July

6.5.3 Scientific surveys

6.5.3.1 Method 1 Pelagic survey in EU waters

No hydroacoustic survey on anchovy was reported by the EU countries. Outside the EU waters, a new set of data was considered in the 2013 assessment. The data set is composed of a series of midwater trawl surveys conducted by former USSR in May (1980-1990) targeting to estimate SSB of Black Sea anchovy. In addition to the historical data, in the hydroacoustic surveys (see the following bullet), complementary pelagic trawl sampling was performed to determine size/age distribution of anchovies. The net used in the pelagic trawl sampling designed to catch both fast swimming adults and small sized recruits at the same time. It has very fine mesh size (14 mm stretched) and equipped with a pair of SIMRAD trawl sensors attached to head rope and bottom line.

6.5.3.2 Method 2 Hydroacoustic survey in EU water

No hydroacoustic survey on anchovy was reported by the EU countries. Concerning outside the EU waters, two different survey data was taken into consideration; i) the historic surveys carried out by former USSR and Ukraine (1980-1988, 1991, 1998-2003); ii) the surveys conducted within the Turkish National Data Collection framework (2011-2013). Concerning the latter, five surveys were carried out in 2011 (November-December), 2012 (January-February; November, December) and 2013 (July, November; Figure 6.5.3.2.1).

6.5.3.2.1 Geographical distribution patterns

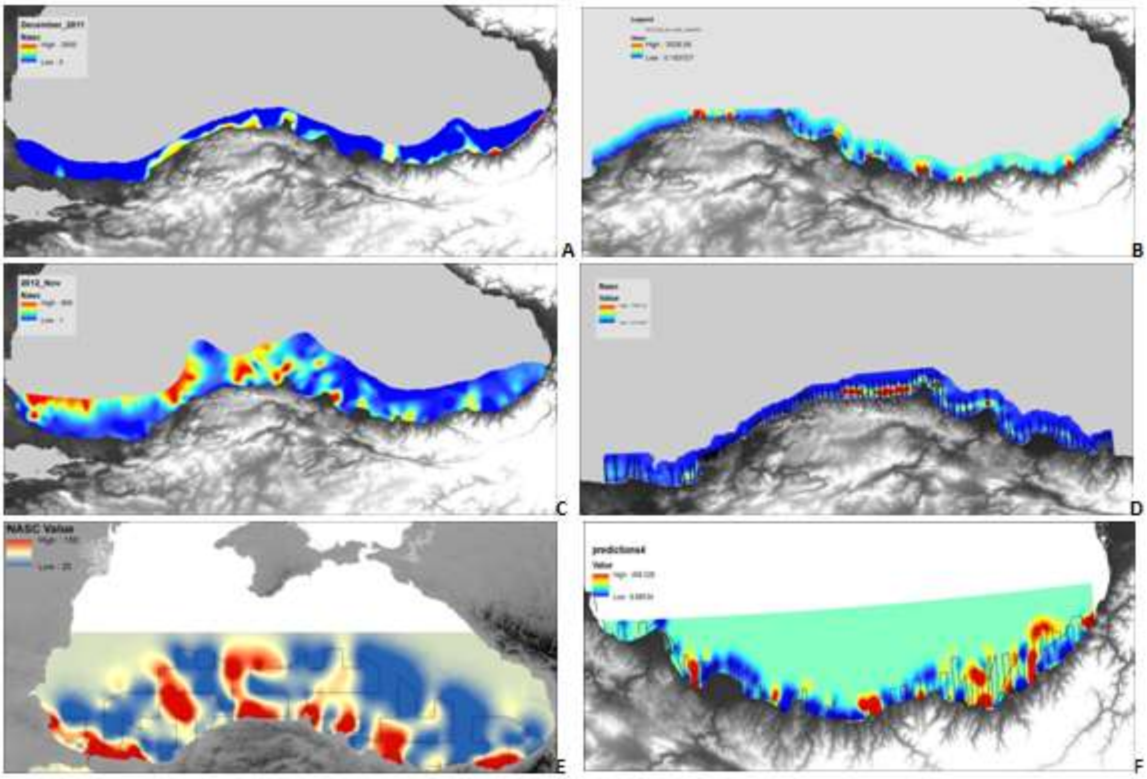


Figure 6.5.3.2.1 Distribution of anchovy; A: December2011; B: Jan-Feb 2012; C: November 2012; D: December 2012; E: July 2013; F: November 2013

6.5.3.2.2 Trends in abundance at length or age

Since 1988, Central Fisheries Research Institute, SUMEA monitors the biological parameters of the anchovy landed on the eastern coast of the Turkey. The study was initiated in 1988 and continued until 1998. After 6-7 years of interruption, the monitoring program has been initiated again and continued since then. The main parameters measured are monthly length/weight frequency distributions of the landed anchovies, ALKs, and somatic condition of the species. The length-frequency distribution of anchovies sampled at the landing sites are given infig 6.5.3.2.2.1. The data follows a quite similar pattern every year; school forming overwintering anchovy arrives in Turkish coast in November. Usually, the large sized anchovy of age class I and older arrives first and the 0 year class appears on the overwintering ground only after a month or two. A by far great percentage of anchovy is fished within the first two months (6.5.3.2.2.2).

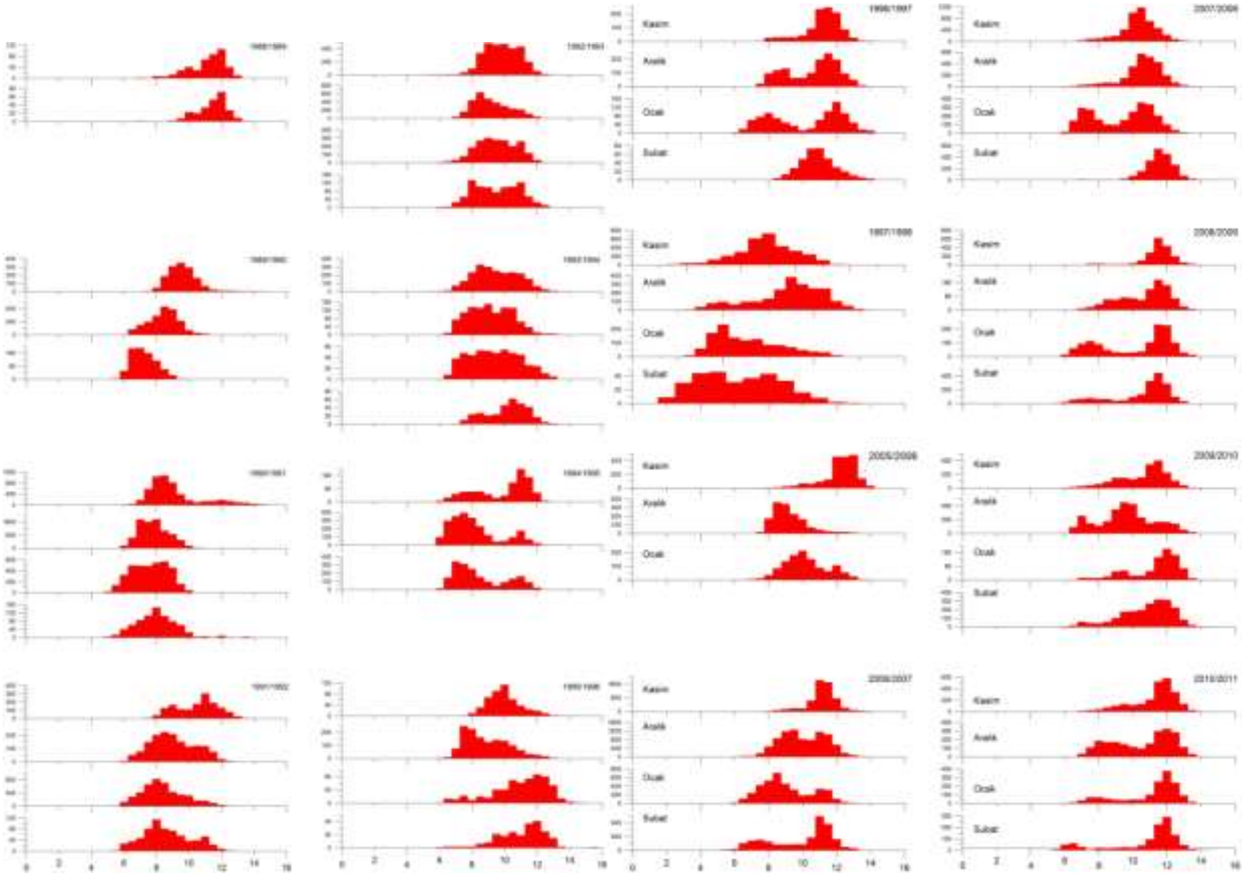


Figure 6.5.3.2.2.1. Monthly length-frequency distribution of the Turkish anchovy landings

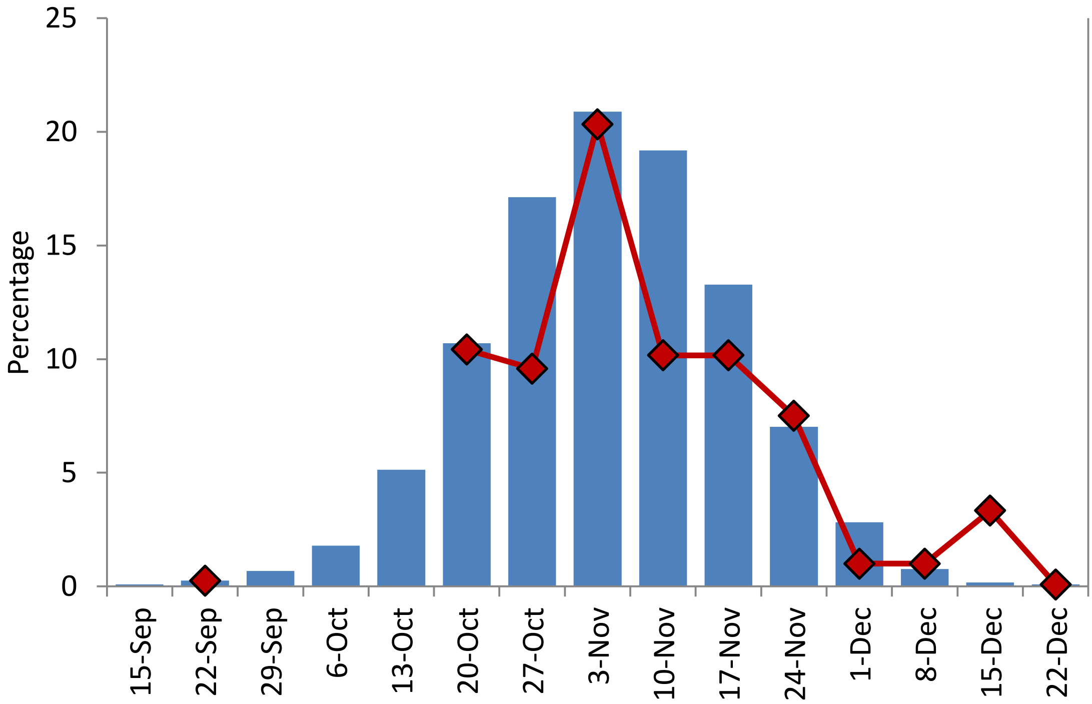


Figure 6.5.3.2.2.2 Weekly distribution of anchovy landings of Turkey (line: observed, bars: normalized)

6.5.3.2.3 Trends in growth

One important concern is the mixing with Azov anchovy. All Black Sea experts involved in the assessment agreed on the fact that overwintering habitat of Azov and Black Sea anchovies overlap in some years. It is also agreed by all experts that the two subspecies display significantly different growth rates. With the data at hand, it is impossible to comment on growth trends as it is not clear whether the trend in growth is due to the status of the Black Sea stock or due to an increased share of slow growing Azov anchovy. Fig 6.5.3.2.3.1 shows the annual changes in the mean weight of anchovy.

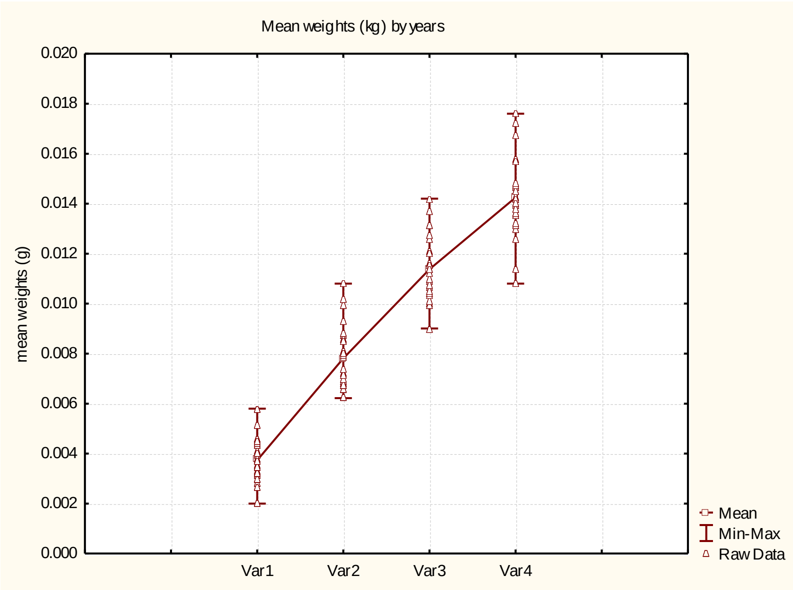


Figure 6.5.3.2.3.1 Variations in the mean weight of age classes

6.5.3.2.4 Trends in maturity

No changes are foreseen neither for 2013 nor for the rest of the dataset

6.5.3.2.5 Abundance and biomass

The results of the surveys conducted to estimate abundance and biomass of the Black Sea anchovy are depicted in fig 6.5.3.2.5.1.

6.5.4 Assessment of historical parameters

6.5.4.1 Method 1 : XSA

6.5.4.1.1 Justification

XSA, when applied to short lived species such as anchovy, has considerable drawbacks. Yet, lack of harmonization in the otolith interpretations among different countries and even among the experts of the same country weakens the appropriateness of the method for anchovy stock assessment. On the other hand the anchovy stock in the Black Sea was first assessed by STECF in 2011 and XSA has always been the major method used for assessment since very beginning. Therefore in this assessment the priority is given to this method to ensure consistency with the previous works.

6.5.4.1.2 Input parameters

Table 6.5.4.1.2.1 Data used in XSA

LA(1)	catch in tonnes	1988 - 2013	Total	
CN(2)	catch-at-age in numbers	1988 - 2013	2 - 4+	
CW(3)	Weight-at-age in the commercial catch		1988 - 2013	2 - 4+
SW(4)	Weight-at-age of the spawning stock		1988 - 2013	2 - 4+
NM(5)	natural mortality	1988 - 2013	2 - 4+	
MO(6)	Proportion mature-at-age	1988 - 2013	2 - 4+	
PF(7)%	of fishing mortality before spawning		assumed 0.00	
PM(8)%	of natural mortality before spawning-			assumed 0.00
TUN				
CPUE of Turkish purse seine fleet		1988 - 2007		
Hydroacoustic survey (former USSR)		1988		
Ukrainian hydroacoustic survey in Georgia		1992, 1996 - 2001		
Turkish hydroacoustic survey		2011-2013		

XSA control parameters: x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=0.5, rage=3, qage=4, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)

The anchovy landings by countries can be traced back to 1950s; however neither age nor length composition data is available before 1988. The historical catch at age data used in the XSA assessment was taken from the previous assessment carried out in 2012. In the previous assessments (2010 and 2011), experts provided data pertaining to their countries. In 2012, Turkish catch at age data was re-estimated based on length-frequency distribution of the commercial catch monitored by Trabzon Fisheries Central Fisheries Research Institute (SUMAE) and the ALKs provided by the same institute. To fill the gaps in the missing years some literature data were also used. In 2011, 2012 and 2013 the data collected within the Turkish Fisheries Data Collection Frame[1] (TFDCF) work was simply added to the historical data.

Catch-at-age data for 2013 are derived from the raised national landings statistics by countries and added to the historic catch at age data set compiled during the previous meetings. SOP correction was applied to level off the inconsistency in the model derived and actual landings). In 2012, a remarkable part of the 0 year class anchovies were discarded, and estimated discard was treated as unreported catch and simply added to the official landings and to the catch at age data. In 2013 (apparently recruitment was not as strong as in 2012) discarded anchovy was negligibly low; hence disregarded.

The countries provided the mean weights of the age classes; for the data concerning the Turkish catch during the period between 1988 and 2010 were taken from SUMAE. For the 2011-2013 period TDCF was used.

Given that the results, particularly the reference point used (E=04), is very sensitive to the natural mortality (M), the estimate used in the previous assessments was not changed. The 2012 assessment uses Gislason's estimator of M.

For the sake of consistency, the maturity pattern is adopted from the previous assessment and it was assumed that the anchovy reaches to maturity at the end of the first year.

[1] TUBITAK-KAMAG 110G124 – Turkish Ministry of Food, Agriculture and Live stocks

Table 6.5.4.1.2.2. The number of fish in catch apportioned into age classes (X10e6)

Year/age	0	I	II	III	IV+
1988	2165842	15011518	13371602	579129	0.001
1989	16430588	5220147	252370	81006	0.001
1990	16682296	1243132	403251	125648	0.001
1991	10515780	4523684	854903	45262	0.001
1992	13457543	12080268	1177327	26407	0.001
1993	19240499	15583511	2629967	147657	0.001
1994	42079752	15897946	2939827	24386	0.001
1995	25590787	21918772	8556294	1236664	0.001
1996	16213594	15724393	6964770	947668	0.001
1997	5838738	13528032	6155538	768176	0.001
1998	5393433	12464597	5659399	705716	111
1999	8812114	20147374	8969151	1117438	68
2000	7322427	17378033	7606441	947861	229
2001	1647360	12232027	11844515	2312884	0.001
2002	1800825	14500081	13827570	2700455	0.001
2003	1573805	11757985	10970980	2135997	0.001
2004	8113535	16438121	9020434	718386	0.001
2005	6033023	3666938	4598032	325143	0.001
2006	14559142	11646123	4848459	162853	0.001
2007	23494265	19872673	7563556	224247	0.001
2008	8219549	12261714	8570209	318182	0.001
2009	10249653	9531493	5185010	199283	0.001
2010	7323812	10027425	9899744	428497	0.001
2011	9225602	13582799	6086328	326309	66482
2012	23786624	10899264	2191995	218372	149377
2013	5394813	21266934	5805574	392522	0.001

Table 6.5.4.1.2.3 Mean weights of the age classes (g/kg)

Year/age	0	I	II	III	IV+
1988	0.003	0.006	0.011	0.015	0.022
1989	0.003	0.006	0.011	0.015	0.022
1990	0.003	0.007	0.013	0.016	0.022
1991	0.003	0.007	0.011	0.015	0.022
1992	0.003	0.007	0.010	0.014	0.022
1993	0.003	0.007	0.011	0.014	0.022
1994	0.003	0.007	0.010	0.014	0.022
1995	0.003	0.007	0.011	0.014	0.022
1996	0.003	0.007	0.011	0.014	0.022
1997	0.004	0.008	0.012	0.014	0.022
1998	0.005	0.011	0.014	0.017	0.022
1999	0.004	0.010	0.012	0.013	0.022
2000	0.002	0.007	0.013	0.017	0.022
2001	0.005	0.010	0.013	0.014	0.022
2002	0.004	0.008	0.012	0.016	0.022
2003	0.006	0.007	0.014	0.018	0.022

2004	0.005	0.009	0.010	0.013	0.022
2005	0.004	0.008	0.012	0.014	0.022
2006	0.004	0.008	0.010	0.015	0.022
2007	0.004	0.007	0.010	0.013	0.022
2008	0.003	0.009	0.011	0.014	0.022
2009	0.004	0.008	0.011	0.013	0.022
2010	0.004	0.009	0.011	0.014	0.022
2011	0.004	0.009	0.013	0.015	0.022
2012	0.005	0.009	0.010	0.011	0.022
2013	0.003	0.007	0.009	0.011	0.022

The internal consistency plot of the first tuning index used in XSA (Turkish commercial CPUE) is given in fig 6.5.9 As explained above, the occurrence of 0 age class anchovy in the catch is questionable, therefore in the XSA the 0 age class is eliminated and only the part framed by a squire is used in the assessment.

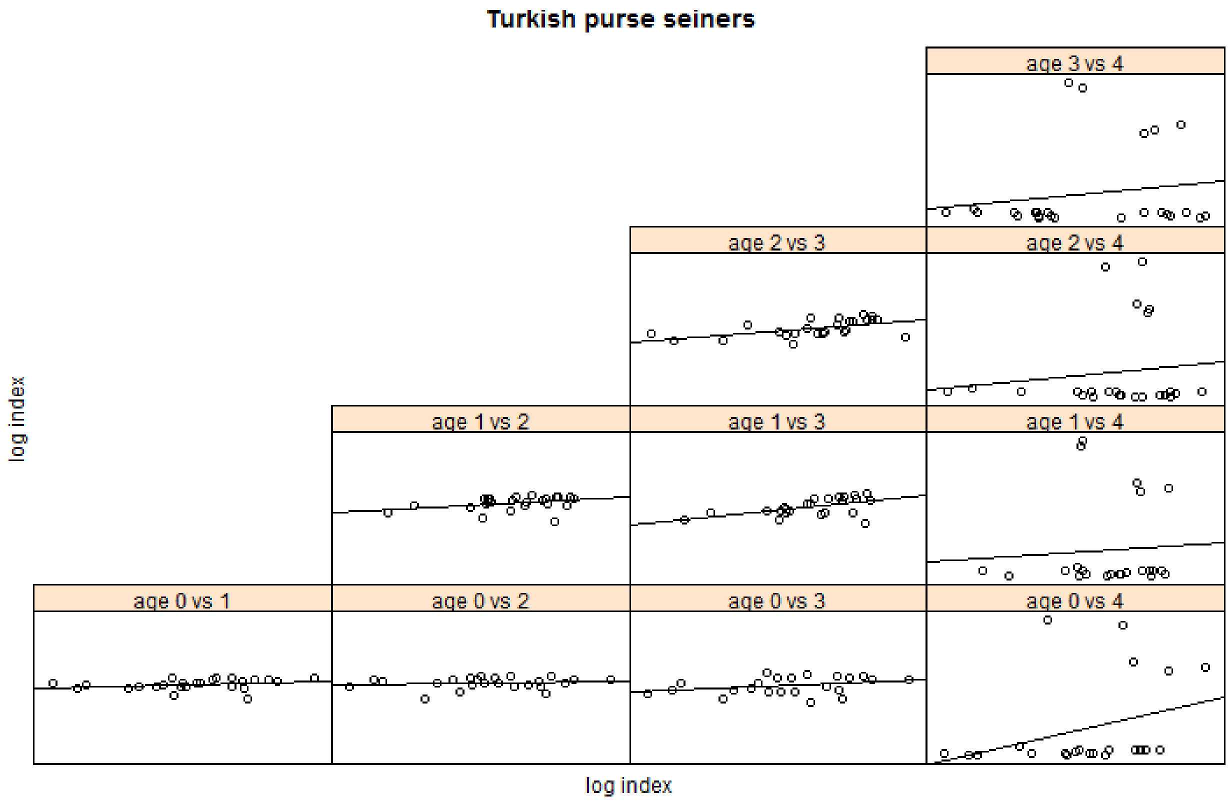


Figure 6.5.4.1.2.1 Internal consistency plot of the first tuning data (Turkish commercial CPUE)

6.5.4.1.3 Results

The XSA model was tested for its sensitivity for the shrinkage used and 4 different values, 0, 0.5, 1.5 and 2.05 were tested. The results are presented below. The group decided to use 1.5 shrinkage which produced lower and randomly distributed residuals (fig 6.5.4.1.3.5 and better restrospective analysis results (6.5.4.1.3.4)

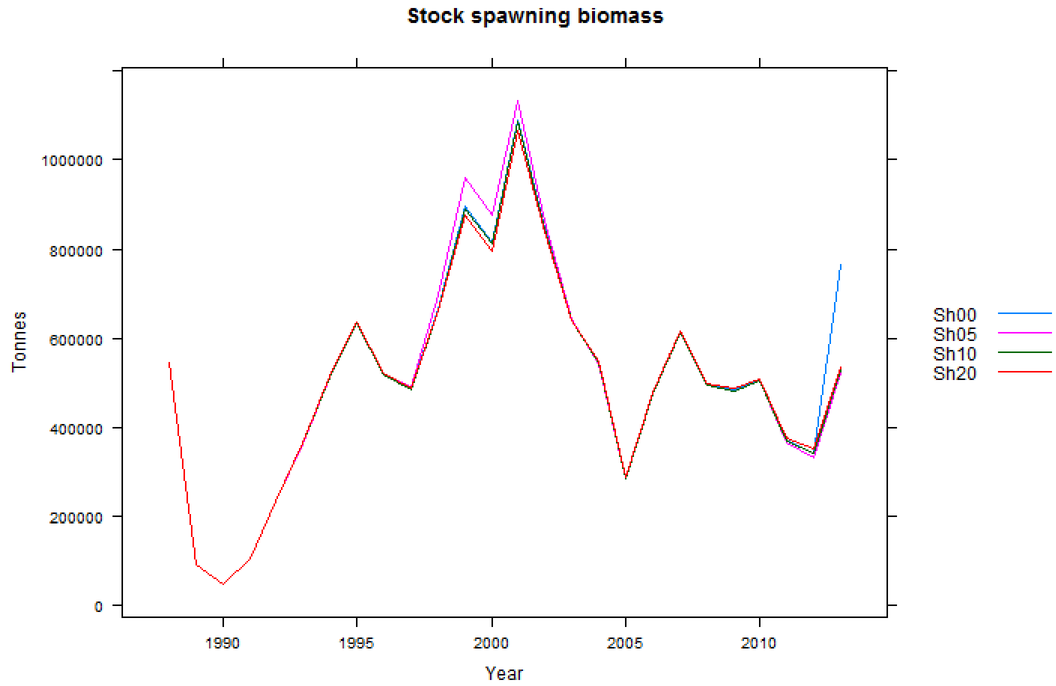


Figure 6.5.4.1.3.1 XSA results: Spawning stock biomass estimates by 0, 0.5, 1.5 and 2.5 shrinkage.

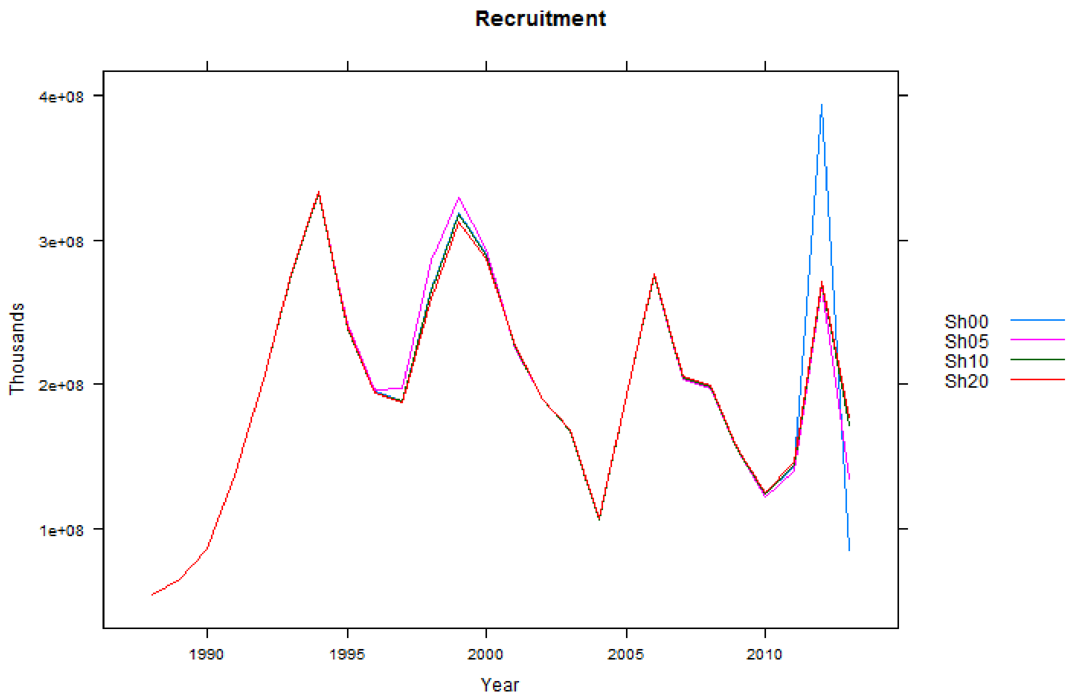


Figure 6.5.4.1.3.2. XSA results: Recruitment estimates by 0, 0.5, 1.5 and 2.5 shrinkage.

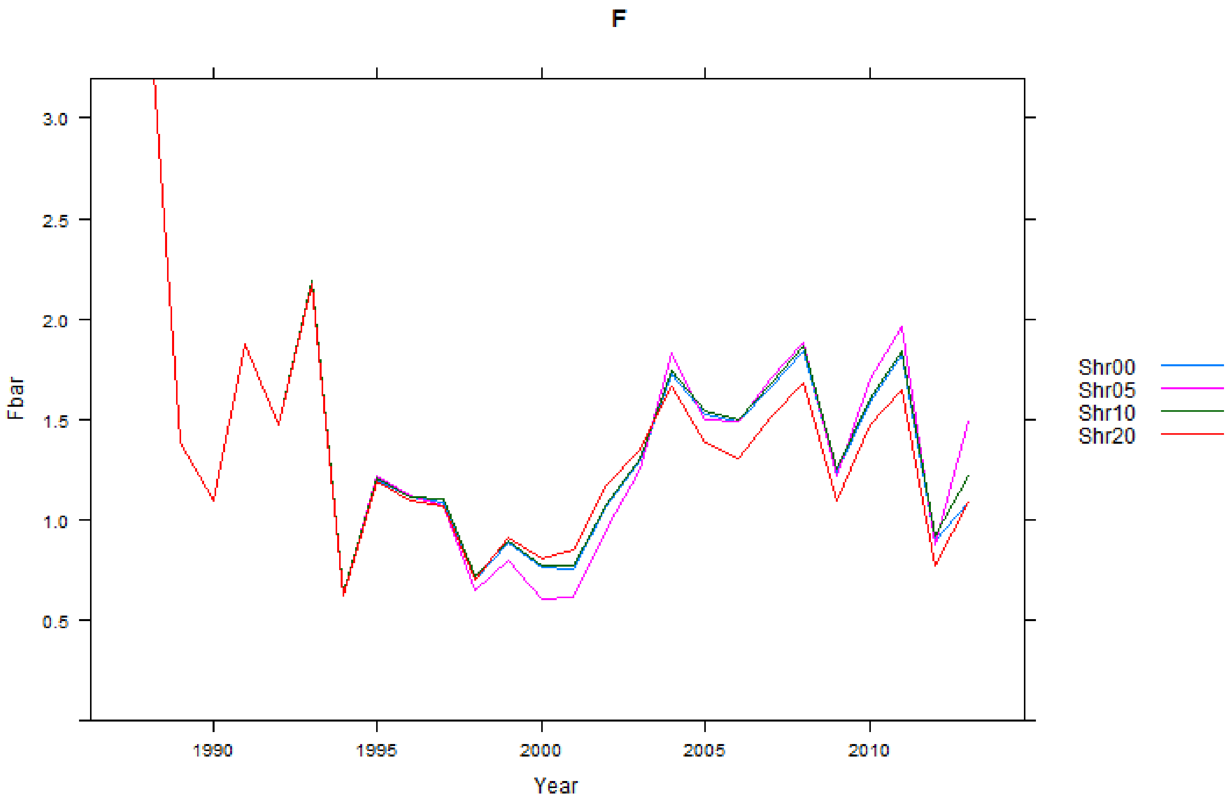


Figure 6.5.4.1.3.3 XSA results: Fishing mortality estimates by 0, 0.5, 1.5 and 2.5 shrinkage.

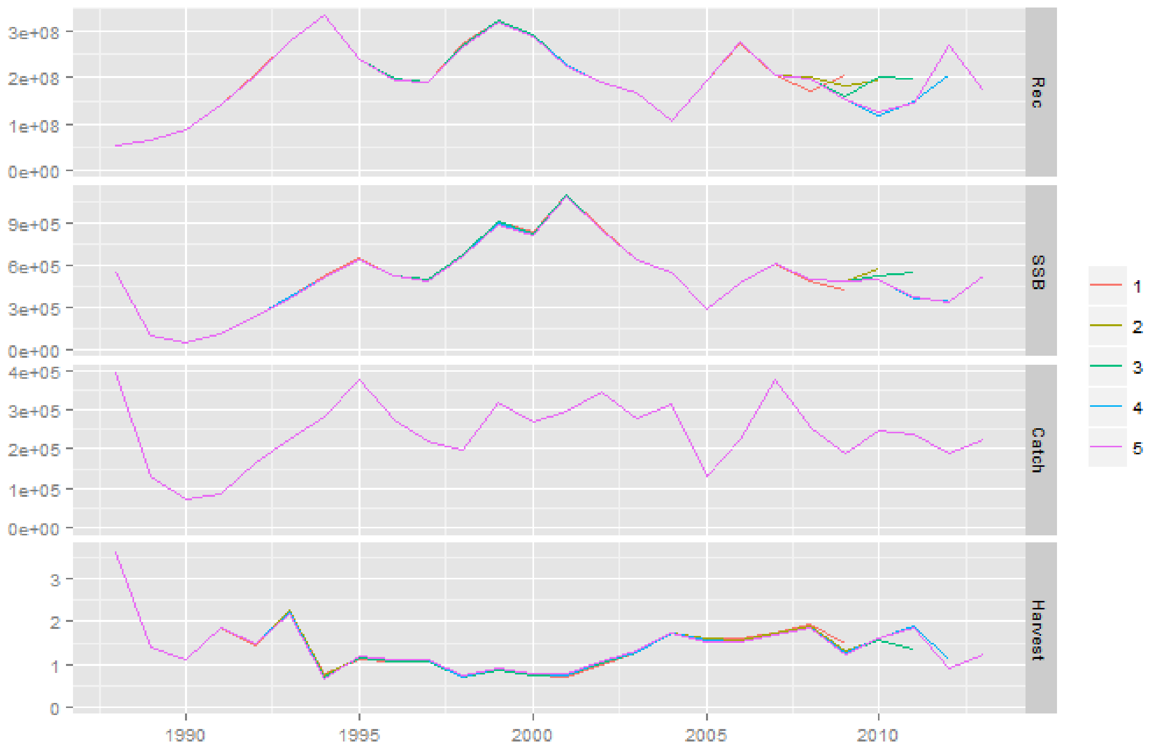


Figure 6.5.4.1.3.4. Retrospective analysis results of the XSA for 1.5 shrinkage (5 years @ last 2 ages)

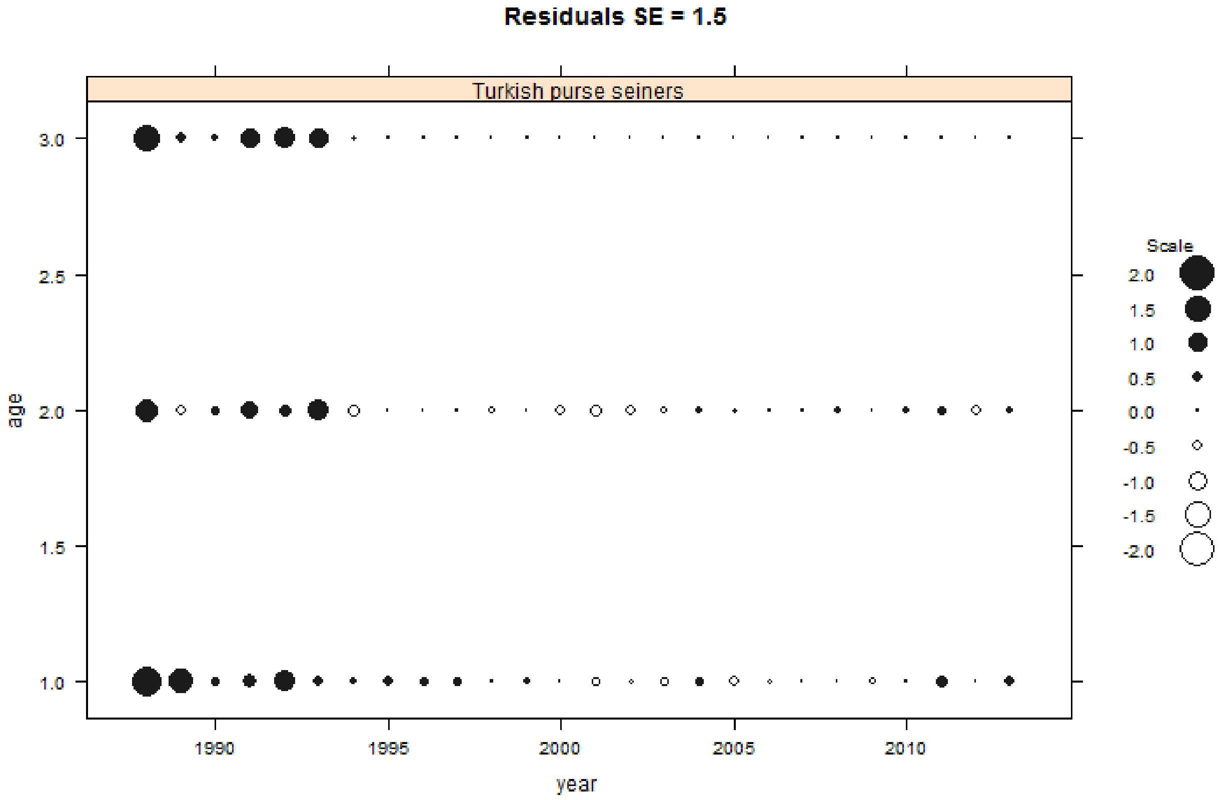


Figure 6.5.4.1.3.5 Residual distribution of the XSA applied with 1.5 shrinkage

The results of the analysis display a very strong year class entry in 2012, which, as all assessment results agrees, increased the SSB in the following year. The F, however, which had been dropped noticeably, increased again in 2013. The current exploitation rate (E=0.59) exceeds the precautionary threshold 0.4 recommended for small pelagic fish. On the other hand, the high variance of the F estimates averaged over the last 5 years hampers to make meaningful short term predictions.

In all model runs recruitment displayed a cyclic pattern with peaking values observed in 1994, 1999, 2006, 2012 (fig 6.5.4.1.3.2), which usually followed by a drop within the last 25 years (fig 6.5.4.1.3.1.). The pulse of a strong year class usually effects the next years SSB. This is what happened in 2013; the strong recruitment gave rise to the number of spawners next year. Estimated F is very much dependent on the level and type of shrinkage used in the XSA assessment (fig 6.5.4.1.3.3). General trend in the last ten years, however, indicates a slight decrease in the fisheries mortality.

6.5.4.1.4 Short term prediction of stock biomass and catch

6.5.4.1.4.1 Justification

The current exploitation rate (E=0.59) exceeds the precautionary threshold 0.4 recommended for small pelagic fish. On the other hand, the high variance of the F estimates averaged over the last 5 years hampers to make meaningful short term predictions.

6.5.4.1.4.2 Input parameters

The data at hand was not sufficient to produce stock recruitment relation to set biological reference points, and therefore precautionary exploitation rate (E=0.4) is used to

6.5.4.1.4.3 Results

The XSA estimates the current $F_{(1:3)}$ for 2013 as 1.2, which is higher than the F_{MSY} (0.56) estimated based on precautionary exploitation rate. The average of the last 5 years' F estimate is 1.37 ($\pm$ 0.36).

6.5.4.2 Method 2: ASPIC

6.5.4.2.1 Justification

Considering the aging and mixing problems mentioned above, the Black Sea anchovy stock was assessed applying a non-equilibrium stock production model.

6.5.4.2.2 Input parameters

In contrary to 2012 assessment the data series used in the assessment has been expanded and three new data sets were added. The Turkish purse seine CPUE was expanded until 1970 and two new fleet data were added. The first is the CPUE for the former USSR for the same period concerned and the second is the Turkish purse seiners fishing in the Georgian water.. In addition to the CPUE data overwintering (Chashchin, 2007) and spawning stock biomass estimates (Chashchin, 1998) were also added to the model.

The control parameters used in the analysis is given in table 6.5.4.2.2.1.

Table 6.5.4.2.2.1. Control parameters used in ASPIC

FIT	## 1) Run type (FIT, BOT, or IRF)
"1970-2013 Black Sea anchovy "	## 2)Title
LOGISTIC YLD SSE	## 3)
222	## 4) Verbosity
500	## 5) Number of bootstrap trials, <= 1000
0 30000	## 6) 0=no MC search, 1=search, 2=repeated srch; N trials
1.0d-08	## 7) Convergence crit. for simplex
3.0d-4 20	## 8) Convergence crit. for restarts, N restarts
1.0d-04 24	## 9) Conv. crit. for F; N steps/yr for gen. model
4.0d0	## 10) Maximum F when cond. on yield
0.0d0	## 11) Stat weight for B1>K as residual (usually 0 or 1)
4	## 12) Number of fisheries (data series)
1.0d0 1.0d0 1.0d0 1.0d0	## 13) Statistical weights for data series
0.5	## 14) B1/K (starting guess, usually 0 to 1)
250000	## 15) MSY (starting guess)
700000	## 16) K (carrying capacity) (starting guess)
0.001 0.0011 1	## 17) q (starting guesses -- 1 per data series)
0 1 1 1 1 1 1	## 18) Estimate flags (0 or 1) (B1/K,MSY,K,q1...qn)
150000 500000	## 19) Min and max constraints -- MSY
300000 1500000	## 20) Min and max constraints -- K
3763	## 21) Random number seed
44	## 22) Number of years of data in each series

The datasets were tested for consistency, i.e. they need to be mutually and positively correlated. As most of the datasets were correlated positively (table 6.5.4.2.2.2) Georgian data did not fulfil the conditions and therefore, for the sake of simplicity, the Georgian catch was added to the Turkish landings.

Table 6.5.4.2.2.2. Correlation among input series expressed as CPUE and degrees of freedom

	1	2	3	4
1 Turkish+Georgian	1.000			
	(44)			
2 USSR	0.567	1.000		
	(31)	(31)		
3 Winter-Hydroacoustics	0.415	0.366	1.000	
	(15)	(12)	(15)	
4 SSB	0.434	0.534	0.665	1.000
	(15)	(12)	(9)	(15)

6.5.4.2.3 Results

The results of the analysis are given under Table 6.5.4.2.3.1 In this case, the residuals are distributed randomly (Figure 6.5.4.2.3.1). The estimated CPUE captured the general fluctuation pattern in the Turkish+Georgian CPUE with appreciable success (fig 6.5.4.2.3.5); however the deviance in USSR CPUE is very high (fig 6.5.4.2.3.3) and this is reflected in the contrast index, which is slightly higher that the acceptable level (0.68; table 6.5.4.2.3.1). The consistency between two independent biomass estimates and the model is at least within the same order of magnitude (figs 6.5.4.2.3.4 - 6.5.4.2.3.5)

Table 6.5.4.2.3.1. Goodness-of-fit and weighting

Loss component		Weighted SSE	N	Weighted MSE	Current weight	Inv.var. weight	R-squared in CPUE
Loss(0)	Penalty for B1 > K		N/A				
Loss(1)	Tur+Geo	8.658	44	0.2061	1	1.881	0.48
Loss(2)	USSR	76.89	31	2.652	1	0.1462	-0.192
Loss(3)	Hydroacoustic	5.686	15	0.4374	1	0.8865	-5.471
Loss(4)	SSB	17.19	15	1.322	1	0.2933	-8.359
TOTAL OBJECTIVE FUNCTION,				MSE, RMSE:		108.4	1.074 1.036

Estimated contrast index (good=0.5 best=1.0): 0.6824 Mean of B coverage proportions > and < B_{MSY}

Estimated nearness index (best=1.0): 1 Proportional closeness of B to B_{MSY}

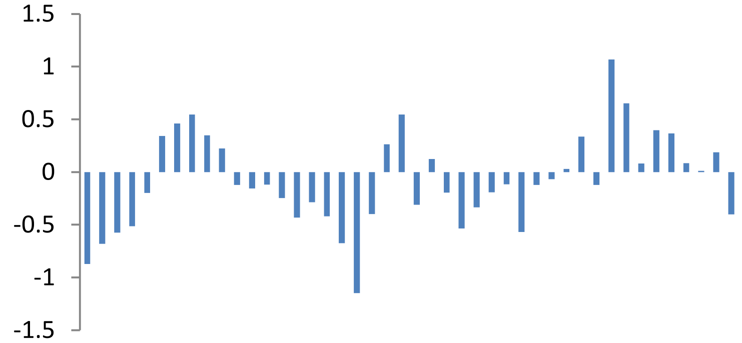


Figure 6.5.4.2.3.1. Log residual distribution of the ASPIC model

The ASPIC model estimated the MSY as 330 000 tons (table 6.5.8 - 6.5.9). The corresponding fishing mortality that would yield MSY is estimated as 0.51. The ASPIC estimate of MSY is quite close to the F_{MSY} estimated based on XSA estimated F_{CUR} and precautionary exploitation rate (E=0.4 $\Rightarrow$ $F_{MSY\text{-}XSA}$ = 0.56)

Table 6.5.4.2.3.2. ASPIC model parameter estimates

Parameter	Estimate	User/pgm	guess			
B1/K	Starting	relative	biomass	(in	1	
MSY	Max sustainable yield	329700	250000	223400	1	1
K	Max population size	1292000	700000	1340000	1	1
phi	Shape (Bmsy/K)	0.5	0.5	----	0	1

Catchability Coefficients by Data Series

q(1)	Turkish+Georgia	2.18E-03	1.00E-03	4.10E-04	1	1
q(2)	USSR	3.25E-04	1.00E-03	7.60E-04	1	1
q(3)	Hydroacoustic	1	1	1	0	1
q(4)	SSB	1	1	1	0	1

Table 6.5.4.2.3.3.. Management and derived parameter estimates

Parameter	**Estimate**
MSY Maximum sustainable yield	329700
B_{MSY} - Stock biomass giving MSY	645800
F_{MSY} Fishing mortality rate at MSY	**0.5106**
B./B_{MSY} Ratio: $B_{(2014)}/B_{MSY}$	0.5029
F./F_{MSY} Ratio: $F_{(2013)}/ F_{MSY}$	1.392
F_{MSY}/F. Ratio: $F_{MSY}/F_{(2013)}$	0.7183
Y.(F_{MSY}) Approx. yield available at F_{MSY} in 2014	186600
Y_e. Equilibrium yield available in 2014	248300

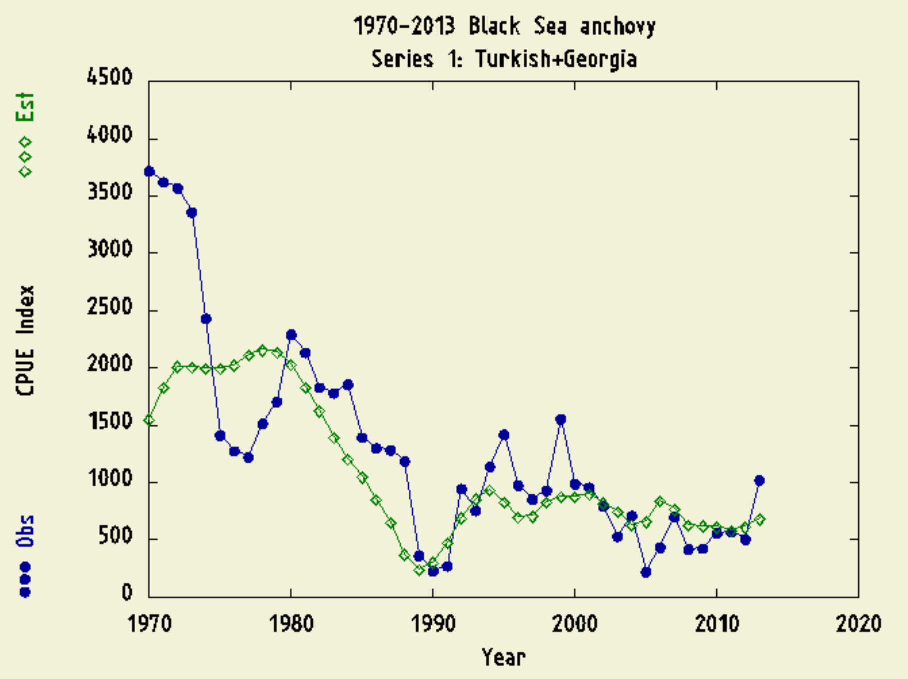


Figure 6.5.4.2.3.2. Observed and modelled Turkish CPUE

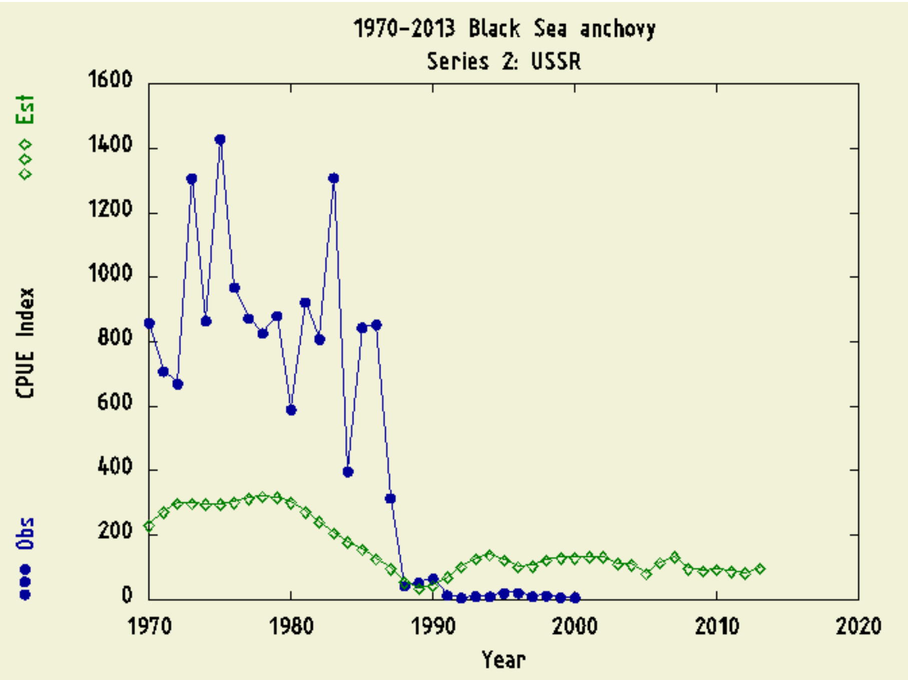


Figure 6.5.4.2.3.3.. Observed and modelled USSR CPUE

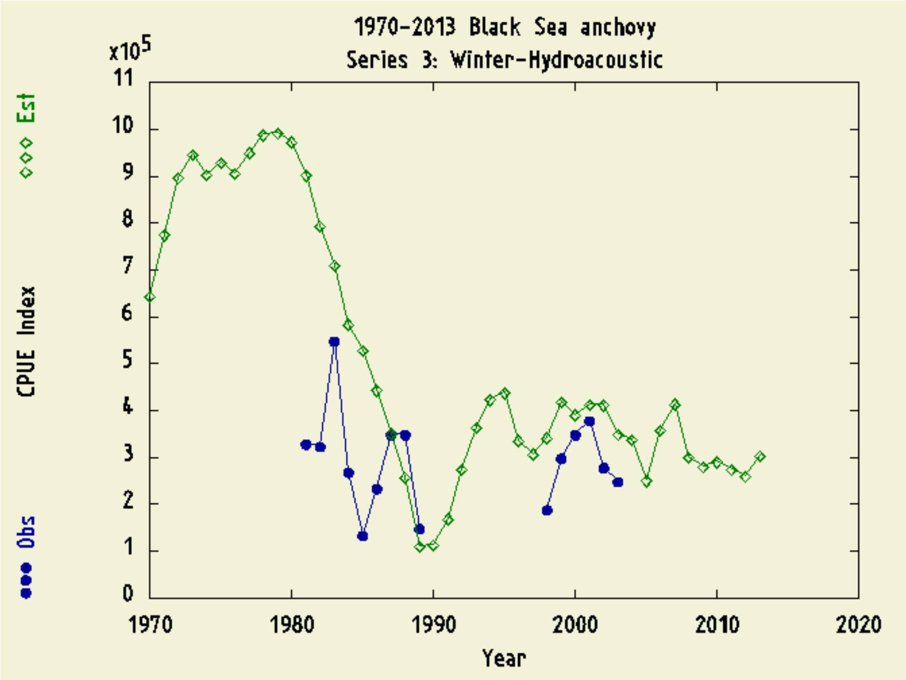


Figure 6.5.4.2.3.4. Modelled vs acoustically observed biomass

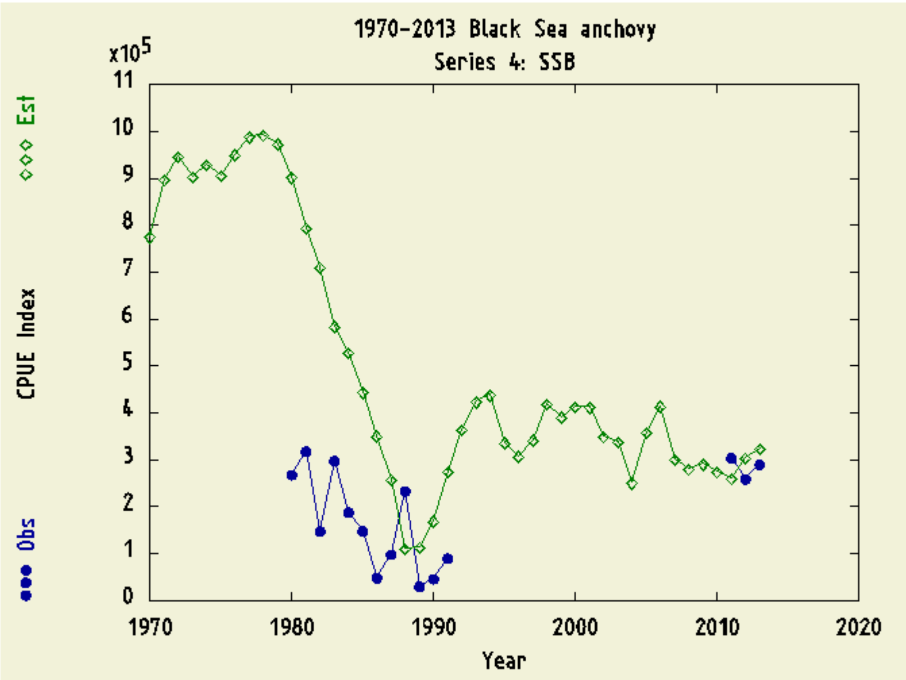


Figure 6.5.4.2.3.5 Modelled biomass vs estimated SSB (midwater trawl survey)

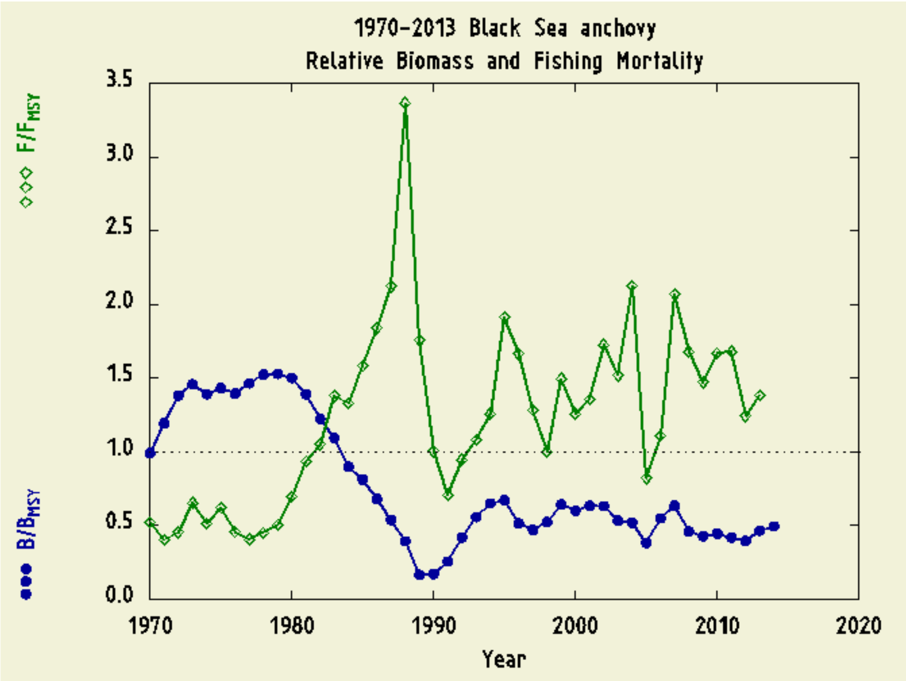


Figure 6.5.4.2.3.6. Status of the stock with respect to F_{MSY} and B_{MSY}

6.5.5 Short to Medium term prediction of stock biomass and catch

6.5.5.1 Justification

There scenarios were tested; FMSY, status qua and F=0

6.5.5.2 Input parameters

For short to medium term predictions (5 years) three different scenarios were assumed. There are five years projection with current fishing mortality (status qua; F=0.71); zero fishing mortality (F=0) and optimum fishing mortality that would produce MSY (F=0.51). All other variables remained unchanged. For statistical consideration bootstrapping was applied to the fitted model outputs (table 6.5.4.2.2.1).

6.5.5.3 Results

The results of all three projections are presented in graphs (figs 6.5.5.3.1-3). Although the confidence interval is quite broad, ASPIC estimated an steady increase in the biomass level with current fishing mortality rate. However, five years period is seemingly not sufficient to reach B_{MSY} (fig 6.5.5.3.1).

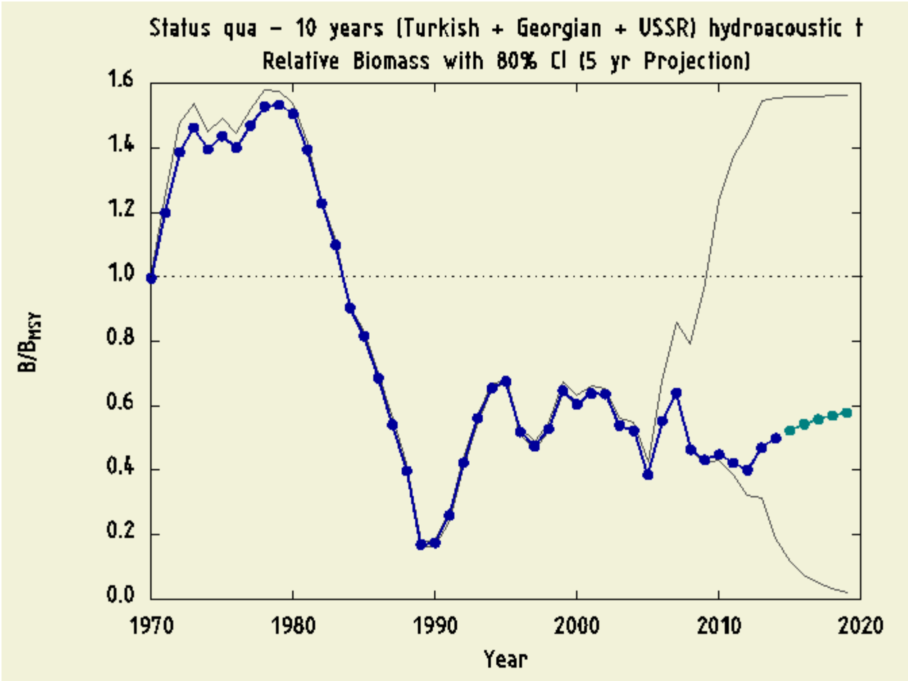


Figure 6.5.5.3.1. 5 years predictions of biomass with current status ($F=F_{2013}=0.71$)

Under zero fishing condition biomass immediately exceed B_{MSY} (fig 6.5.22).

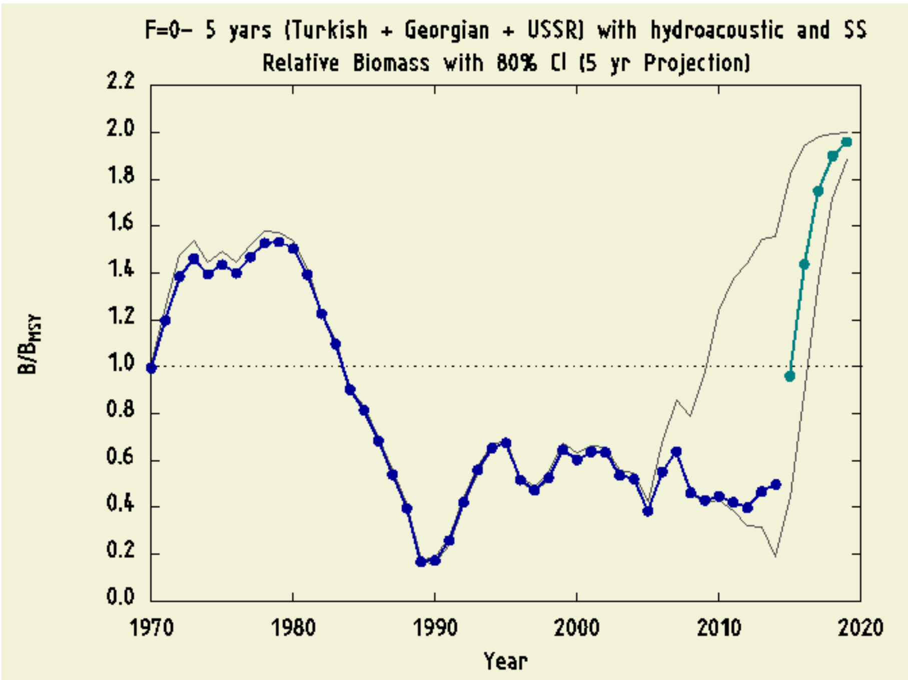


Figure 6.5.5.3.2. 5 years predictions of biomass with no fishing (F=0)

If the current fishing level is immediately reduced to F_{MSY} (F = 0.51) B_{MSY}
Is reached only after 5 years.

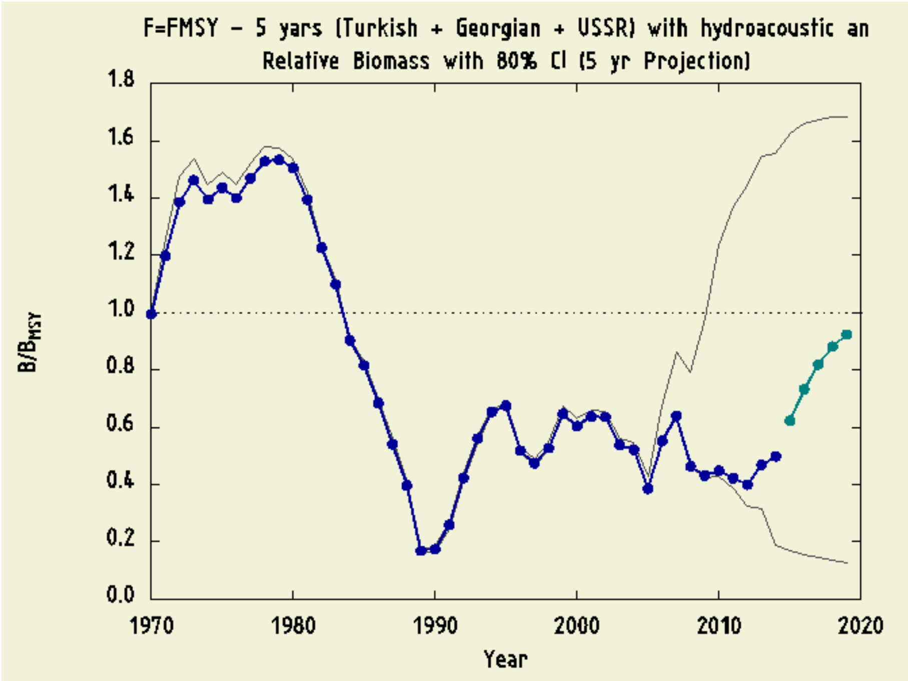


Figure 6.5.5.3.3. 5 years predictions of biomass with fishing mortality producing MSY (F=F_{MSY})

6.5.6 Long term predictions

N/A

6.5.7 Scientific advice

Both of the assessment models, although there are remarkable deviances between their results, suggest a lower F_{MSY} than the current fishing mortality. Given that Turkey, as the main exploiter of the Black Sea anchovy reduced both fishing effort and the level of catch in the last two years at least another year is required to evaluate the response of the stock to the protective measures.

6.6 PIKED DOGFISH IN GSA 29

6.6.1 Biological features

6.6.1.1 Stock Identification

Piked dogfish inhabits the whole Black Sea shelf at water temperatures between 6 – 15º C – Fig. 6.6.1.1.1 and Fig. 6.6.1.1.2. It undertakes extensive migrations. In autumn feeding migrations are aimed at the grounds of the formation of the wintering concentrations of anchovy and horse mackerel in the vicinity of the Crimean Caucasus and Anatolian coasts. With their migrations Piked dogfish disperses all over the shelf. Reproductive migrations of viviparous Piced dogfish take place towards the coastal shallows with two peaks of intensity – in spring and autumn. The autumn migration for reproduction involves more individuals usually. The major grounds for reproduction of Piced dogfish in the Ukrainian waters are located in Karkinitsky Bay, in front of Kerch Strait and in Feodosia Bay.

Piked dogfish belongs to the group of long-living and viviparous fish; therefore reproduction process includes copulation and birth of pups. Near the coasts of Bulgaria, Georgia, Romania, Russian Federation and Ukraine the intense spawning season is in March-May. Two peaks of birth of juveniles can be distinguished – spring period (April-May) and summer-autumn (August-September, Serobaba et al., 1988). To give birth the females approach the coastal zone in depth 10 – 30 m (Maklakova, Taranenko, 1974). At this time males keep separately from females in a depth of 30 – 50 m. The birth of Piked dogfish juveniles takes place at the temperature of water between 12 – 18°C. In autumn piked dogfish aggregates into large schools, accompanying anchovy and horse mackerel, which migrate to wintering grounds along eastern and western coast. During wintering the densest concentrations of Piked dogfish are observed, where Piked dogfish feeds intensively. They are associated, above all, with major wintering areas of anchovy in the waters of Georgia and Turkey. In the North-western Black Sea in the waters of Ukraine and Romania in depth from 70-80 m down to 100-120 m abundant wintering concentrations of Piked dogfish are also observed, where they are located on the grounds of whiting and sprat concentrations (Kirnosova, Lushnicova., 1990).

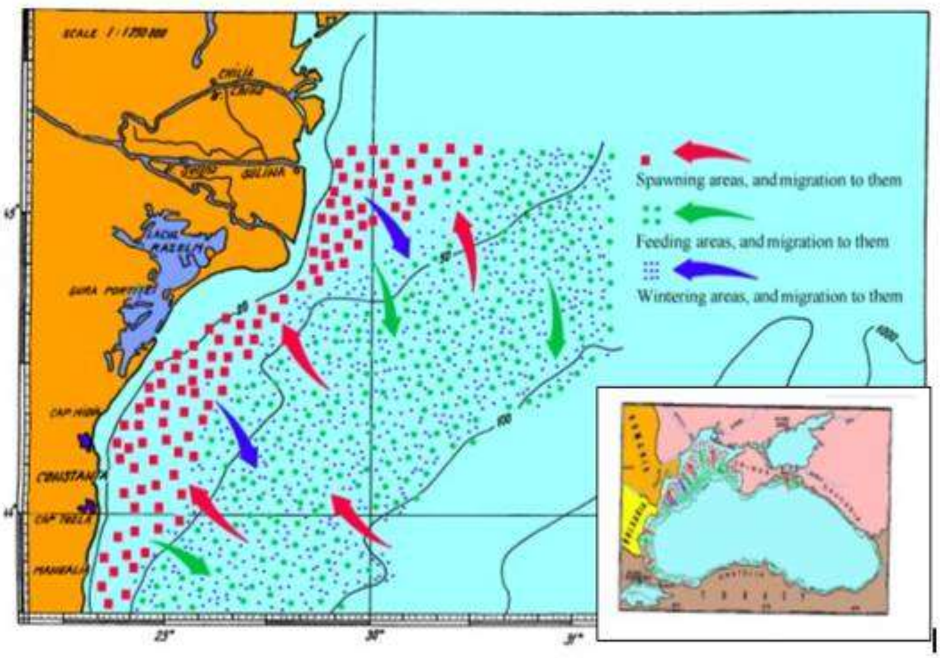


Fig. 6.6.1.1.1 Distribution and migration routes of the piked dogfish at Romanian littoral (Radu et al.,2009b, 2010a).

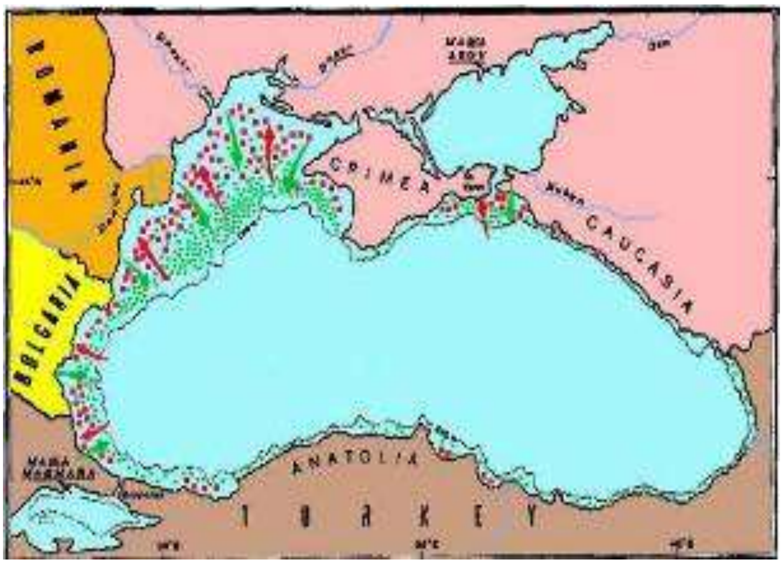


Fig. 6.6.1.1.2 Distribution and migration routes of the piked dogfish at Black Sea level.

6.6.1.2 Stock Structure Assumed in the Assessment

Data regarding landings at age, mean weight at age in the landings, maturity at age and natural mortality at age, growth parameters and mortality rates, maturity ogives at age including information for 2013, were provided to the EWG 14-14 only by Romania and Ukraine. Bulgaria has provided only data on landings. Remaining riparian countries (Georgia, Russia and Turkey) have not provided data.

Catch data for these three countries were estimated at the level of previous years.

Estimates of the size compositions of the catches were provided only by Romania. Analysis of the length and weight classes of the piked dogfish caught during the period 2010-2012 showed the presence of medium-size individuals, with lengths ranging from 89 to 134 cm, but predominantly from 107 to 122 cm. In 2013, the predominant length ranged between 98-113cm.

Table 6.6.1.2.1 Romanian catches in numbers of individuals by length classes.

Year	Catches (t)	Catches in number of individuals and tons per length classes									
			2009		2010		2011		2012		2013
2008	**10.283**										
2009	4.270										
2010	3.069										
2011	3.995										
2012	2.144										
2013	8.681										
year	**Abundance (no.ind.)**	**class (cm)**	**%**	**Abundance**	**%**	**Abundance**	**%**	**Abundance**	**%**	**Abundance**	**%**	**Abun.**
2008	1468	89.5			1.00	4						
2009	670	92.5			0.00	0						
2010	415	95.5			2.00	8						
2011	655	98.5			2.99	12					0.5	6
2012	399	101.5			0.00	0			0.93	4	0.5	6
2013	1114	104.5	1.93	13	0.50	2	6.78	46	0.0	0	1.57	17
		107.5	8.21	55	7.98	33	8.47	61	2.78	11	5.9	66
		110.5	14.98	100	16.46	68	16.95	122	10.19	41	11.16	124

		113.5	19.81	133	23.44	97	28.81	191	34.26	120	17.96	200
		116.6	27.05	181	17.71	74	25.42	157	27.78	91	10	111
		119.5	16.43	110	9.73	40	8.47	51	8.33	26	15.66	174
		122.5	7.24	49	4.49	19	3.39	19	14.81	44	12.83	143
		125.5	1.93	13	2.99	12	0.00	0	0.93	2	7	78
		128.5	0	0	8.73	36	1.69	9			4.05	45
		131.5	1.45	10	2.00	8					4.02	45
		134.5	0	0	0.00	0					4.0	45
		137.5	0.97	7	0.00	0					4.85	54
		Total	**100.0**	**670**	**100.0**	**415**	**100.0**	**655**	**100.0**	**339**	**100**	**1114**

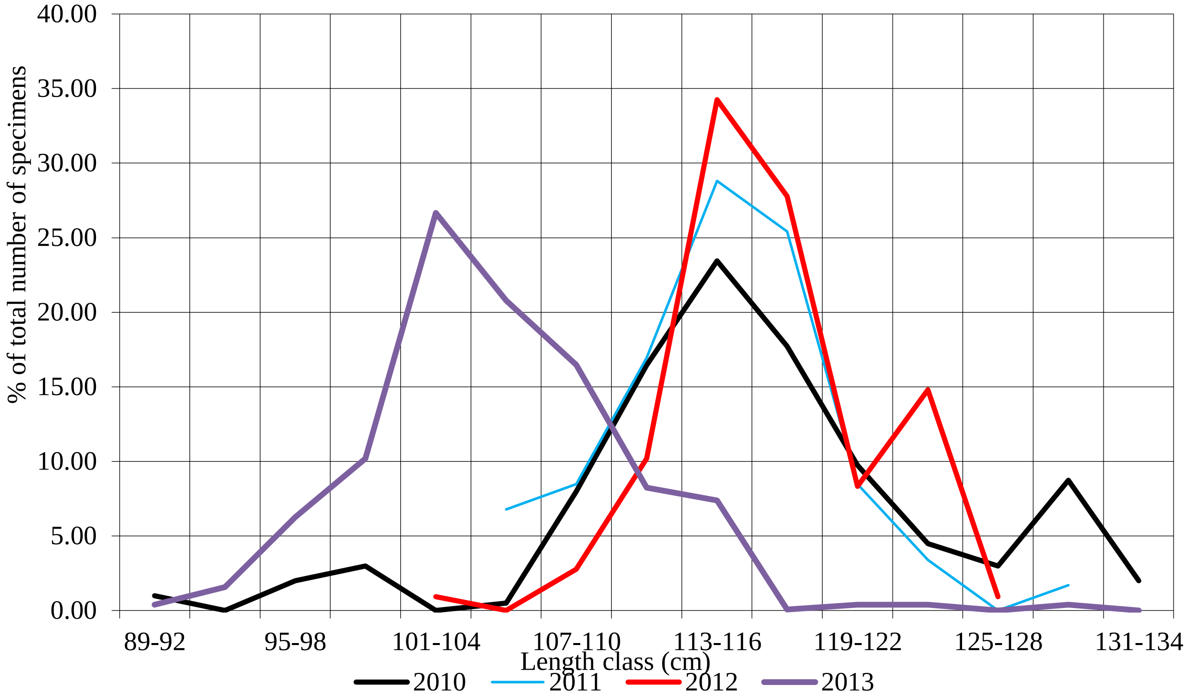


Fig. 6.6.1.2.1 Structure on length classes of the dogfish at Romanian littoral in the last four years

The population data of Piked dogfish at the Romanian Black Sea area are given in the figures bellow (Maximov et al..2010a.c; Radu et al.. 2010a).

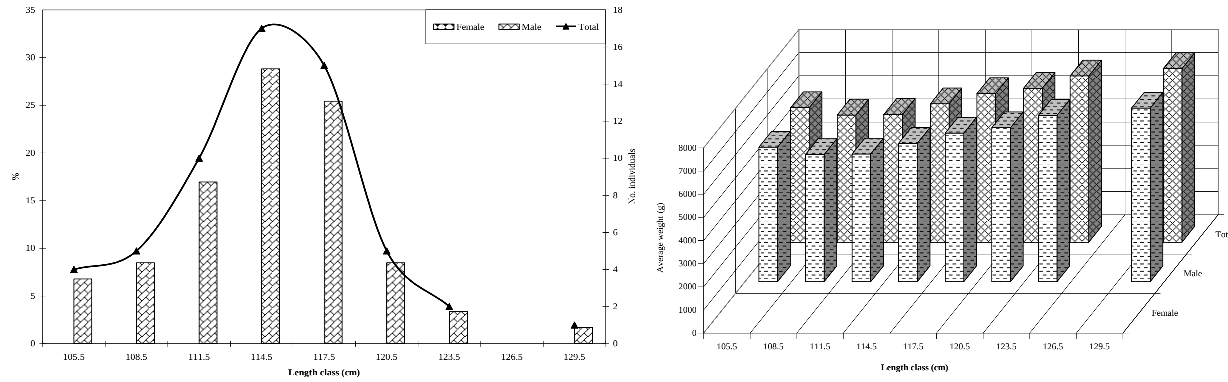


Fig. 6.6.1.2.2 Structure on length classes and average weight for dogfish at Romanian marine area in 2011.

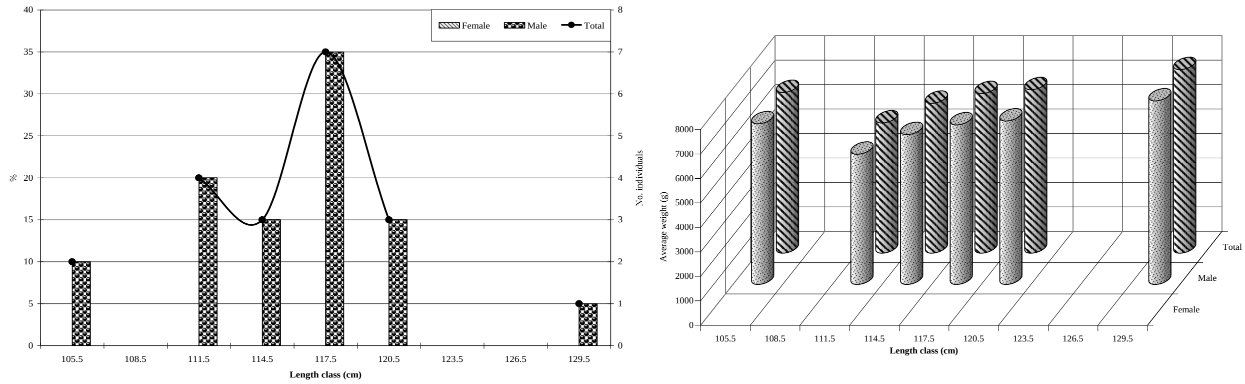


Fig. 6.6.1.2.3 Structure on length classes for dogfish at Romanian marine area in 2011. spring period

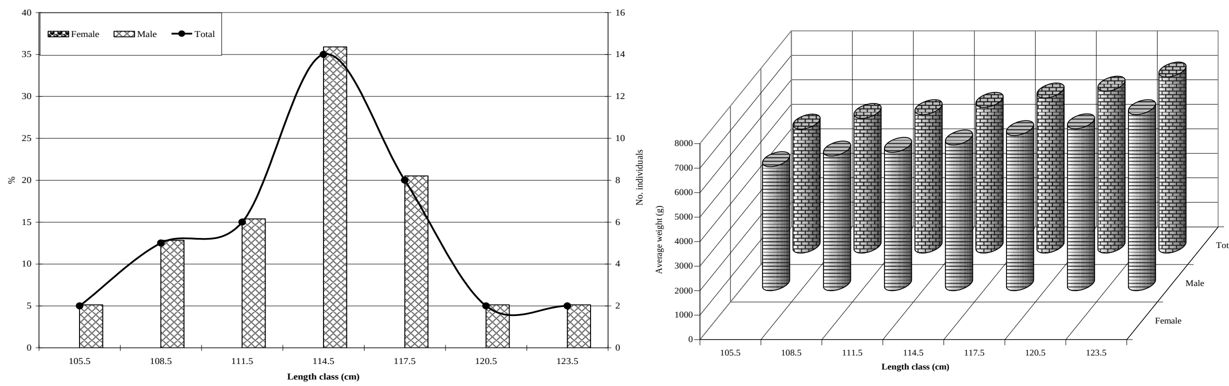


Fig. 6.6.1.2.4 Structure on length classes and average weight for dogfish at Romanian marine area in 2011. autumn period.

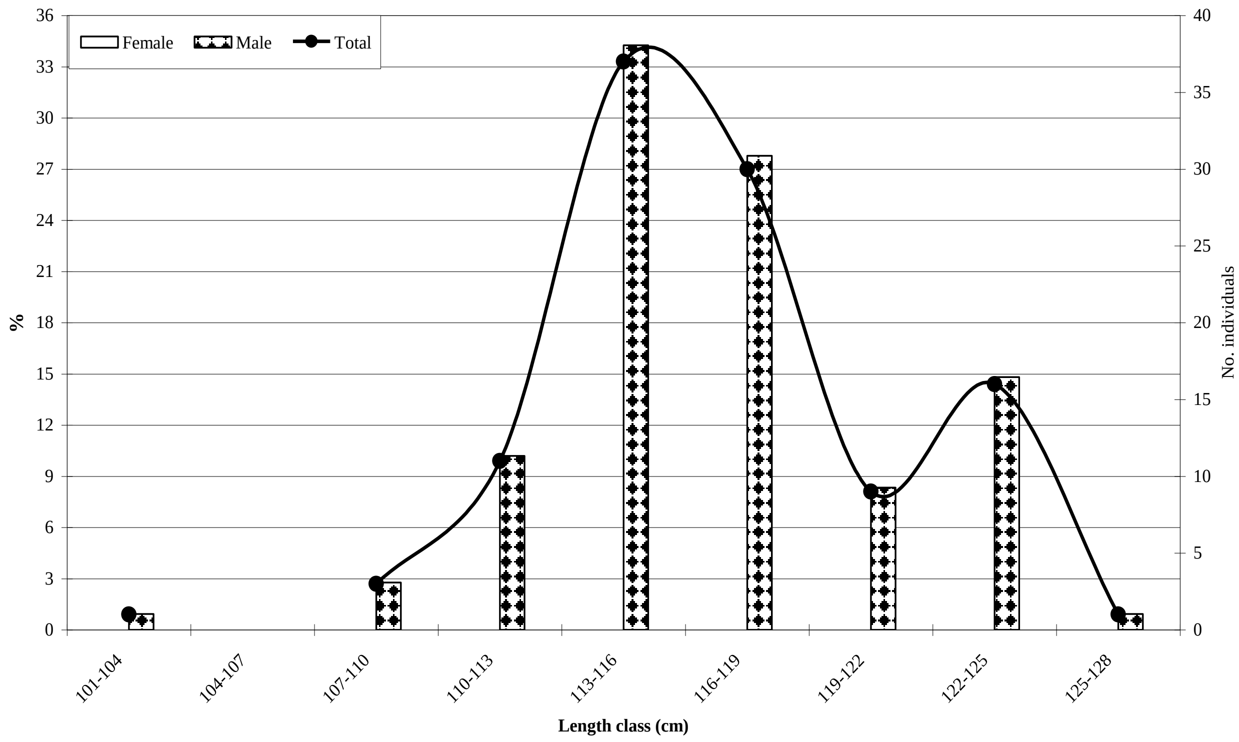


Fig: 6.6.1.2.5 Structure on length classes for dogfish in 2012, total catches

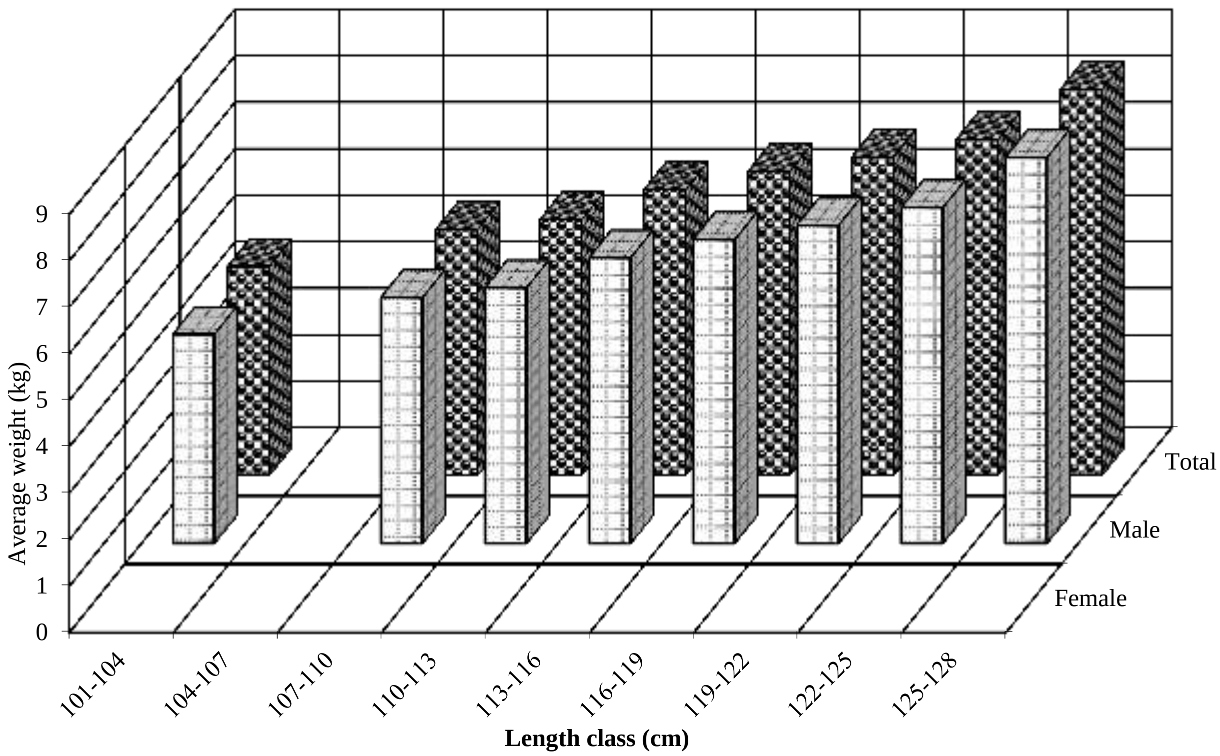


Fig: 6.6.1.2.6 Mean weight on length classes for dogfish 2012, total catches

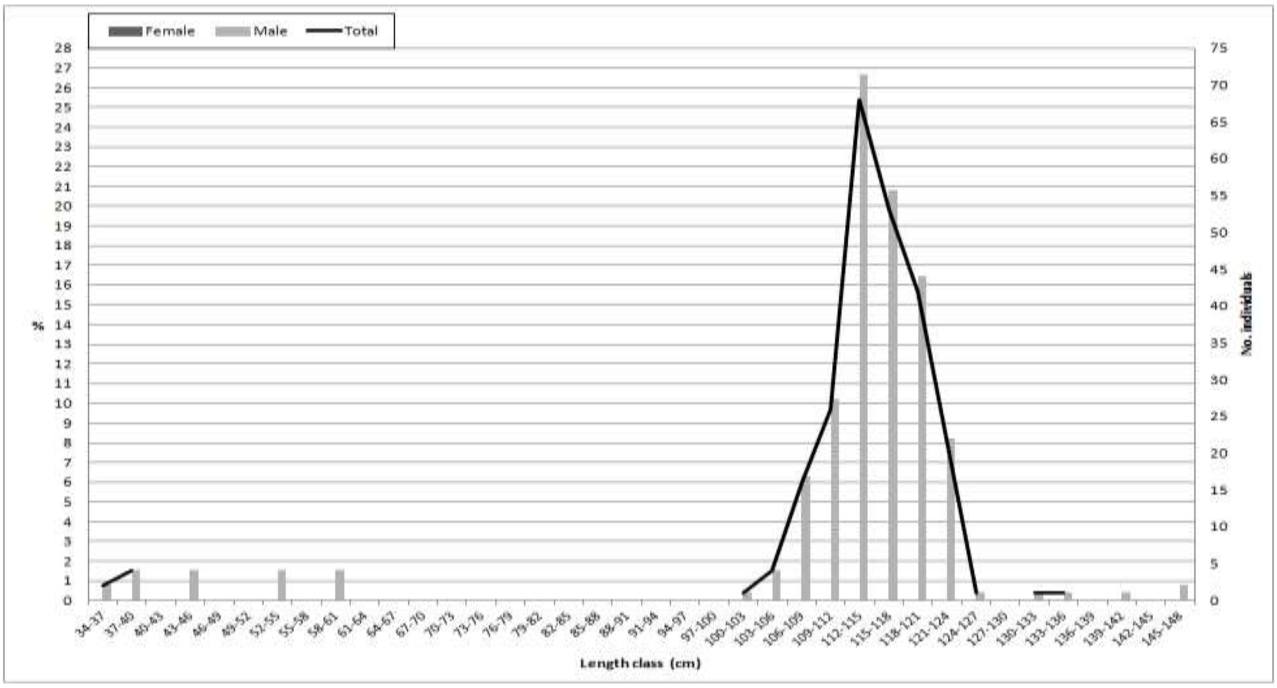


Fig: 6.6.1.2.7 Structure on length classes for dogfish in 2013, surveys

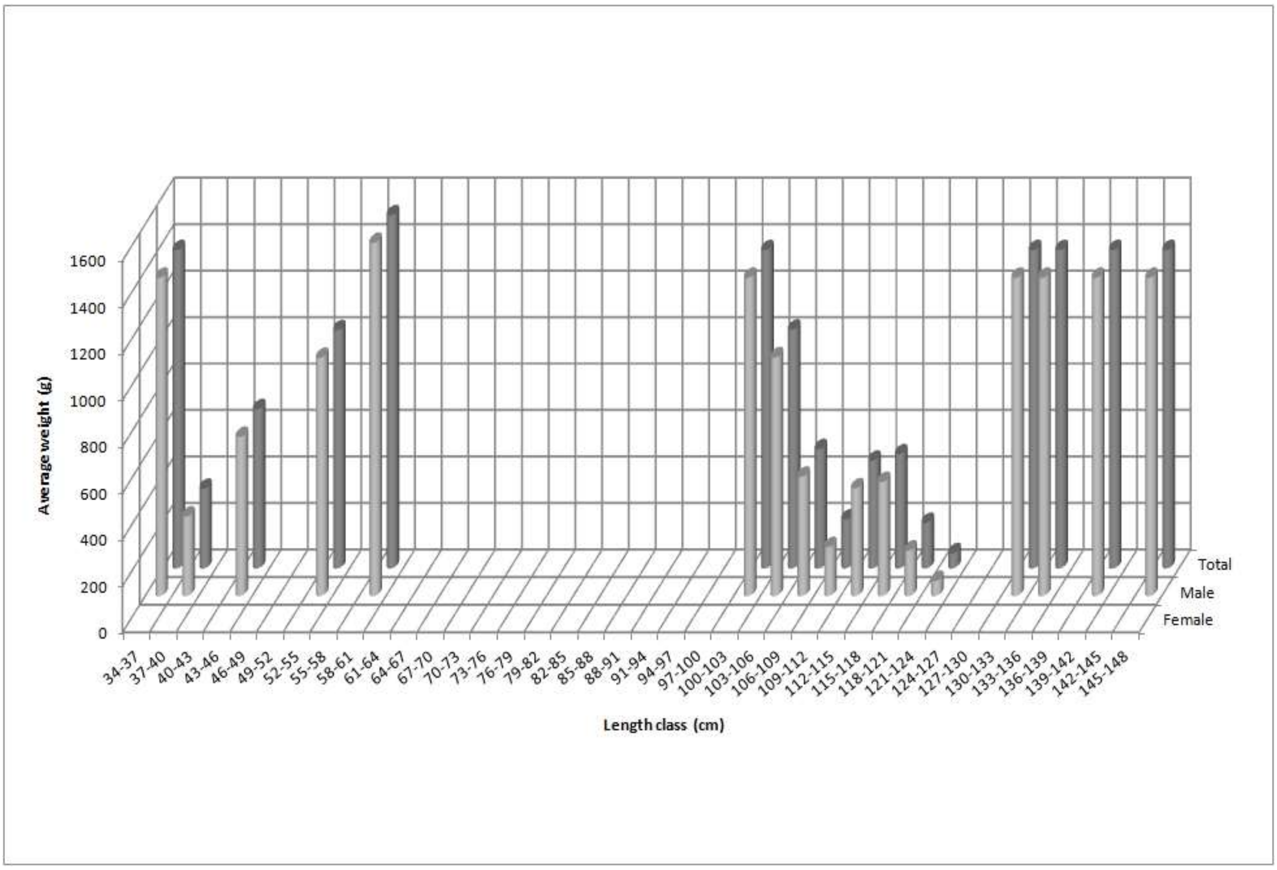


Fig: 6.6.1.2.8 Mean weight on length classes for dogfish 2013, surveys

6.6.1.3 Growth

Piked dogfish is a major demersal predator, reaching the Black Sea the length of about 1.50 m. According to investigations conducted in former USSR waters. Kirnosova. (1993) found that the piked dogfish maximum age is 20 years. The parameters in VBGF and natural mortality parameters are:

Males: K=0.029 t_0=-3.84; L_∞=272 cm; W_∞=47 kg; M=0.20÷0.23

Females: K=0.026 t_0=-3.32; L_∞=303 cm; W_∞=196 kg; M=0.15÷0.20

Age and length, at which 50% of individuals are mature, are 10.49 years and 87.57 cm for males and 11.99 years and 102.97 cm for females, respectively. Mean biennial fecundity is 19.4 eggs and 12.9 pups. The linear relationship between fecundity and length is: F_e = 0.09 x TLp + 2.12 (r = 0.5) for pups and F_o = 0.27 x T Lp - 21.59 (r = 0.7) for eggs (Demirhan and Seyhan. 2007).

Ukrainian data for the period 1971-2001 are: L_∞=282; t_0 = -3.6684 (year); a = 0.00000677; b =2.9593. For period 2002 – 2012 a= 0.00000640; b= 3.0000

Romanian data for the last three years are:

Table 6.6.1.3.1 Main parameters used in assessment for 2011 data

Linf= 136	a= 0.0117
k= 0.191	b= 2.7694
t0= -1.31	M= 0.15 (0.258)

Table 6.6.1.3.2 Main parameters used in assessment for 2012 data

Linf= 157	a= 0.0169769
k= 0.153	b= 2.696436
t0= -1.13684	M= 0.15

Table 6.6.1.3.3 Main parameters used in assessment for 2013 data

Linf= 156	a= 0.061086
k= 0.134	b= 2.41368
t0= -0.9304	M= 0.15 (0.22)

6.6.1.4 Maturity

Life-history parameters and food diet of piked dogfish (*Squalus acanthias*) from the SE Black Sea were studied (Demirhan and Seyhan, 2007). Piked dogfish at age 1 to 14 years old were observed, with dominance of 8 years old individuals for both sexes. The length–weight relationship was W=0.0040*L2·95and the mean annual linear and somatic growth rates were 7.2 cm and 540.1 g, respectively. The estimated parameters in VBGF were: W∞=12021 (g), L∞=157 (cm), K=0.12 (year−1) and t0=−1.30 (year). The size at first maturity was 82 cm for males and 88 cm for females. Mean biennial fecundity was also found to be 8 pups per female. The relationships fecundity–length, fecundity–weight and fecundity–age were found to be:

F=−17.0842+0.2369*L (r=0.93)

F=0.3780+0.0018*W (r=0.89)

F =−0.7859+1.1609*A (r=0.94), respectively.

In conformity with Ukrainian data, the maturity ogive for last years is the following:

Year/ Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.25	0.45	0.55	0.75	0.95	1.0	1.0	1.0	1.0	1.0

Maturity ogive from Romanian data

Year/ Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2011	0.0	0.0	0.45	0.7	0.95	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

6.6.2 Fisheries

6.6.2.1 General Description

In the Black Sea the largest catches of piked dogfish are along the coasts of Turkey, although this fish is not a target species of fisheries, being yielded as by-catch in trawl and purse seine operations mainly in the wintering period. During 1989-1995 annual catches of Turkey were 1055-4558 t (Shlyakhov, Daskalov, 2008). In subsequent years, they have decreased about 2 times and did not exceed 2400 t. In the waters of Ukraine most of piked dogfish is harvested in spring and autumn months by target fishing with gill-nets of 100 mm mesh-size, long-lines, and as by-catch of sprat trawl fisheries. As in Turkish waters, in the last 20 years the maximum annual catches of piked dogfish were observed in 1989-1995, reaching 1200-1300 t. After 1994 the catches went down being between 20 and 200 t. In the rest of countries piked dogfish is harvested mainly as by-catch, annual catches are usually lower than Ukrainian catches. The maximum annual catches of piked dogfish in 1989-2005 were: Bulgaria - 126 t (2001), Georgia - 550 t (1998), Romania - 52 t (1992), Russian Federation - 183 t (1990). It should be noted that in the waters of Bulgaria, the highest catches were observed in the early 2000's. In Romania dogfish is caught mainly as by-catch of the sprat trawl fishery. The catches decreased significantly because of decreasing of the trawling effort (Maximov et al., 2008b, 2010b; Radu et al., 2009b, 2010a,b).

In Turkey, piked dogfish lost its commercial importance in recent years. In the last 20 years, the decrease of dogfish landings may be due to over-fishing (Demirhan , Phd thesis)

In the last three years catches in Bulgaria have increased, being around 40% of total Black sea catches.

6.6.2.2 Management regulations applicable in 2012 and 2013

For EWG 14-14, only Romania has presented data on the management regulations. Romanian fisheries regulatory framework includes between others the following laws:

- Law on Fishing Fund. Fishery and Aquaculture No. 23 /2008;
- Annual Order on the Fishing Prohibition;
- Order no. 342/2008 on minimal size of the aquatic living resources;
- Order nr. 449/2008 on technical characteristics and practice conditions for fishing gears used in the commercial fishing.

Regarding pikedy dogfish, for protecting the reproduction and rehabilitation of the stock the following measures were adopted (Radu G. and Nicolaev S.. 2010):

- period April - June: 60 days; fishing is prohibited;
- it is banned to use the trawl in marine zone shallower than 20 m of depth;
- mesh size for dogfish gillnets: a = 100mm, 2a = 200 mm;
- minimum admissible length in catches is 120cm (TL)

In the Black Sea Fishes list, IUCN status presented on the Black Sea Commission website (www.blacksea-commission.org) *Squalus acanthias* is included and categorized as follows (Table 6.6.2.2.1) in the BSC. 2011:

Table 6.6.2.2.1. The IUCN status of spiny dogfish in the Black Sea countries

Country	BG	GE	RO	RF	TR	UKR
IUCN status	N/A	LC	NT	N/A	EN	NT

LC - least concerned; NT- near threatened; EN- endangered; N/A – no data

6.6.2.3 Catches

6.6.2.3.1 Landings

The landings of Piked dogfish by countries are given on Table 6.6.2.3.1.1.

Table 6.6.2.3.1.1. Piked dogfish landings by countries (FAO Fisheries Statistics, GFCM Capture Production 2006 – 2008, BSC data, input from experts).

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	TOTAL
1989	28	217	30	135	4558	1191	6159
1990	16	128	45	183	1059	1330	2761
1991	21	18	26	67	2017	775	2924
1992	15	14	52	15	2220	595	2911
1993	12	131	6	5	1055	409	1618
1994	12	45	2	11	2432	148	2650
1995	80	31	7	90	1562	67	1837
1996	64	71	5	19	1748	44	1951
1997	40	1	5	9	1510	20	1585
1998	28	550	5	6	855	38	1482
1999	25	18	5	9	1478	94	1629
2000	102	21	5	12	2390	71	2601
2001	126	27	5	27	576	134	895
2002	100	65	5	19	316	97	602
2003	51	40	5	29	184	172	481
2004	47	31	5	34	211	93	421
2005	15	35	5	19	102	75	251
2006	6	10	9	17	193	67	302
2007	24	2	17	32	91	45	211
2008	23	0	10	59	35	79	206
2009	9	2	4	14	159	47	235
2010	42	2	3	9	16	27	98
2011	38	2	4	4	27	31	104
2012	29	2	2	4	25	9	70
2013	31	2	9	4	25	13	83

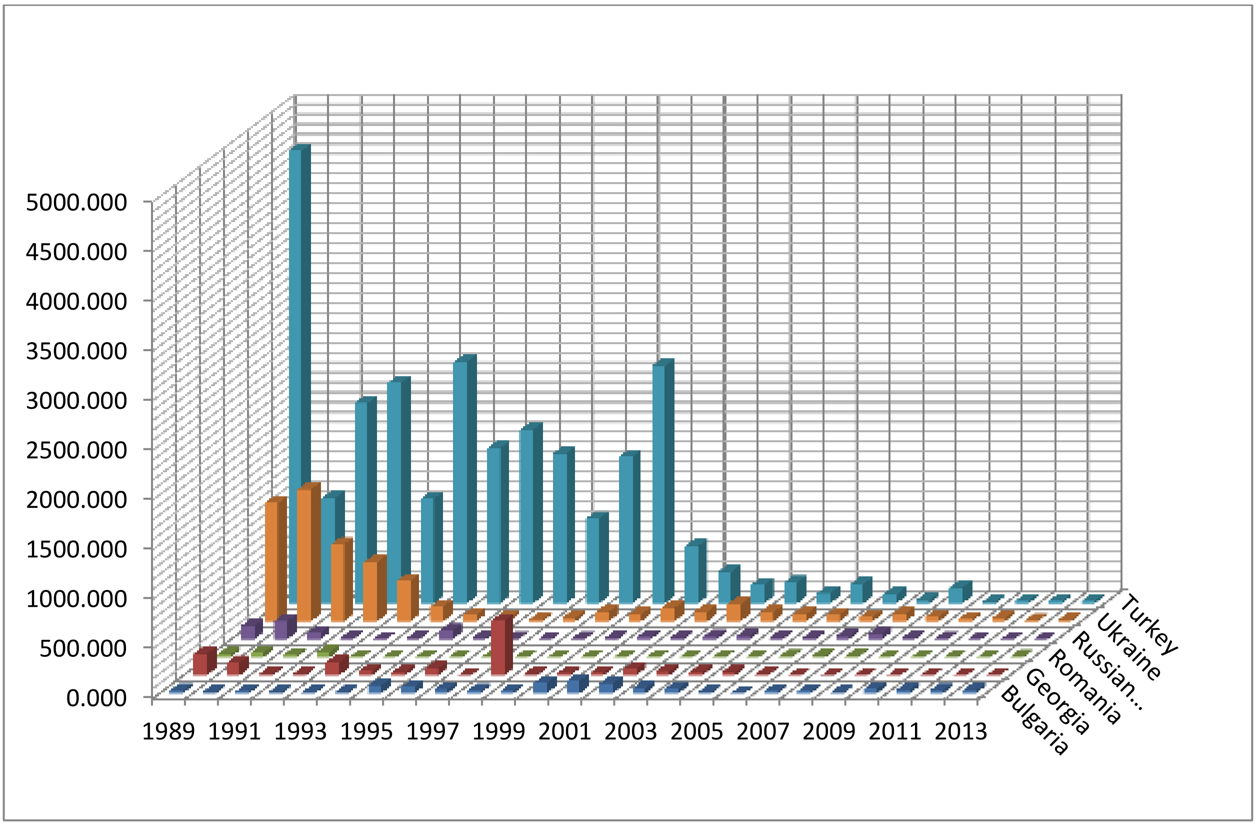


Fig: 6.6.2.3.1.1 Spiny dogfish catches in the Black Sea area (t)

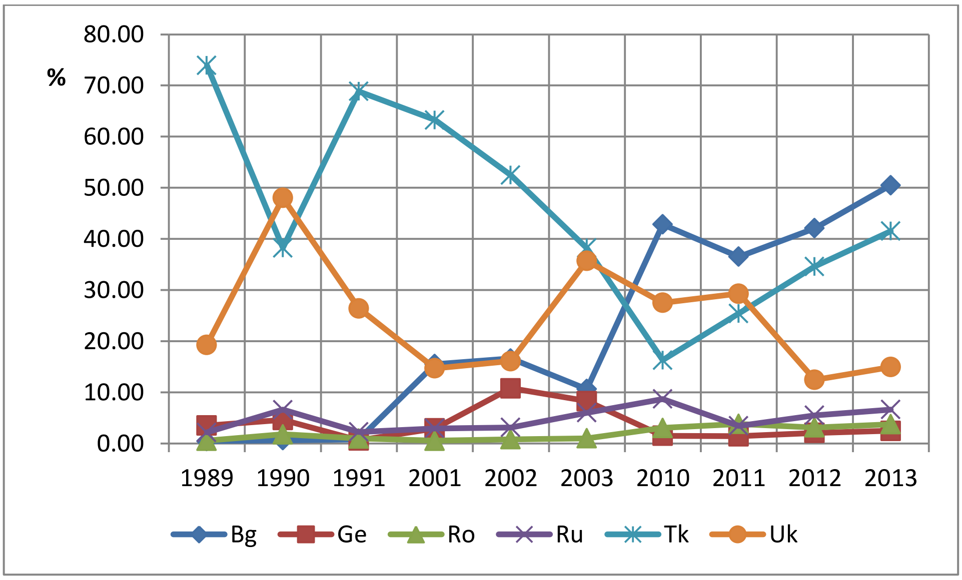


Fig: 6.6.2.3.1.2 Proportion (%) by countries of the catches for the years taken into consideration for assessment

6.6.2.3.2 Discards

For EWG 14-14 only Romania reported 5.5 tons of discard coming mainly from trawl fishery as by-catch.

6.6.2.4 Fishing effort

The EWG 14-14 was not provided with quantitative information on fishing effort by all riparian countries. In 2011, 2012 and 2013 only Romania provided data regarding the number of gillnets by vessel length class. The number of vessels fishing gillnets for dogfish dropped from 265 in 2011 to 160 in 2012 and 25 in 2013.

Table 6.6.2.4.1 Number of fishing gillnets for dogfish in the Romanian area

Vessel length (m)	Number of gillnets for dogfish in 2011	Number of gillnets for dogfish in 2012	Number of gillnets for dogfish in 2013
< 6m	10	-	-
6-12 m	205	110	-
18-24 m	50	50	-
24-40 m	-	-	25
Total	**265**	**160**	**25**

6.6.2.5 Commercial CPUE

The EWG 14-14 has no quantitative information for all riparian countries. In last years, only Romania gives data regarding commercial CPUE for 2009-2012 period and CPUE in at sea surveys for 2010, 2011, 2012 and 2013

Table 6.6.2.5.1 Romanian CPUE in commercial fishing, 2009-2013 period

YEAR	Fishing gear	CPUE
	2009	
LOA 6-12 m	gillnets	0.24 kg/gear/day
LOA 18-24 m	gillnets	0.40 kg/gear/day
LOA 24-40 m	gillnets	0.89 kg/gear/day
	2010	
LOA 6-12 m	gillnets	0.18 kg/gear/day
	2011	
LOA 6-12 m	gillnets	0.248kg/gear/day
LOA 18-24 m	gillnets	0.91 kg/gear/day
	2012	
LOA 6-12 m	gillnets	8.8 kg/gear/day
LOA 12-18 m	gillnets	8.5 kg/gear/day
18-24	gillnets	6.0 kg/gear/day
	2013	
LOA 6-12 m	long lines	20.65 kg/gear/day /
LOA 24-40 m	pelagic trawl	123.45 kg/gear/day
LOA 24-40 m	gillnets	8.91 kg/gear/day

Table 6.6.2.5.2 CPUE in the at sea surveys for Romanian Black Sea areas

YEAR	2010		2011		2012		2013	
Period	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Range (kg/hour)	3.6 – 98.63	4.5 – 106.22	5.8 – 24.9	5.0 -24.83	1.1-19.2	1.5-134	5.5-115.8	0.95-200

6.6.3 Scientific surveys

6.6.3.1 Method 1 Demersal survey in EU waters

6.6.3.1.1 Geographical distribution patterns

For EWG 14-14 only Romania presented data on surveys at sea for dogfish

In Romanian waters the agglomerations are distributed on the entire shelf, but especially at depth deeper than 20m. Two peaks of intense spawning and of birth of juveniles are in spring and autumn period at Romanian littoral.

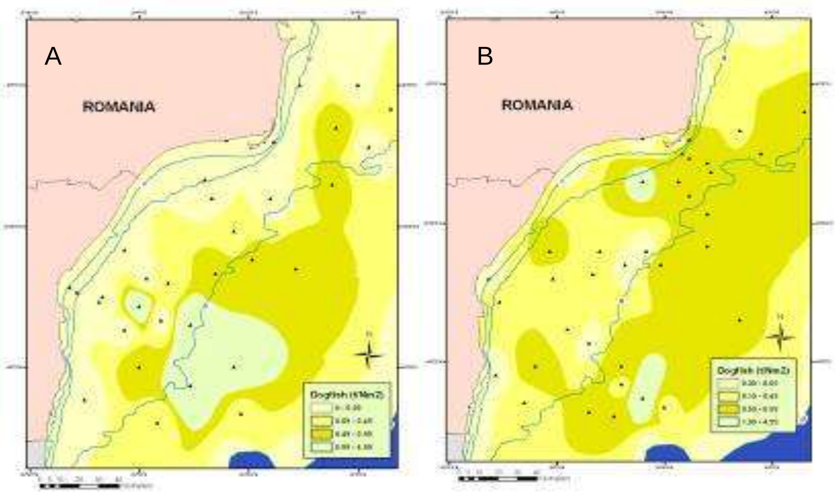


Fig. 6.6.3.1.1.1. Distribution of picked dogfish agglomeration during demersal trawl survey in 2009 (A - spring season. B - autumn season), Romanian Black Sea area.

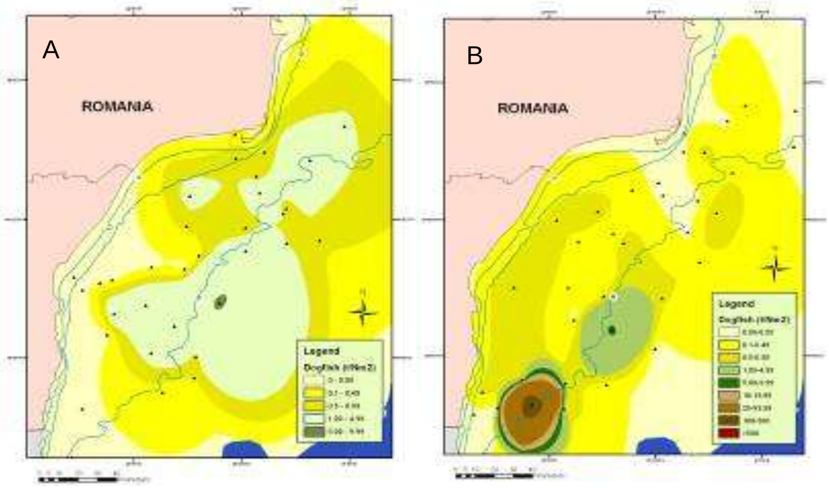


Fig. 6.6.3.1.1.2. Distribution of piked dogfish catches during demersal trawl survey in 2010 (A - spring season. B - autumn season). Romanian Black Sea area.

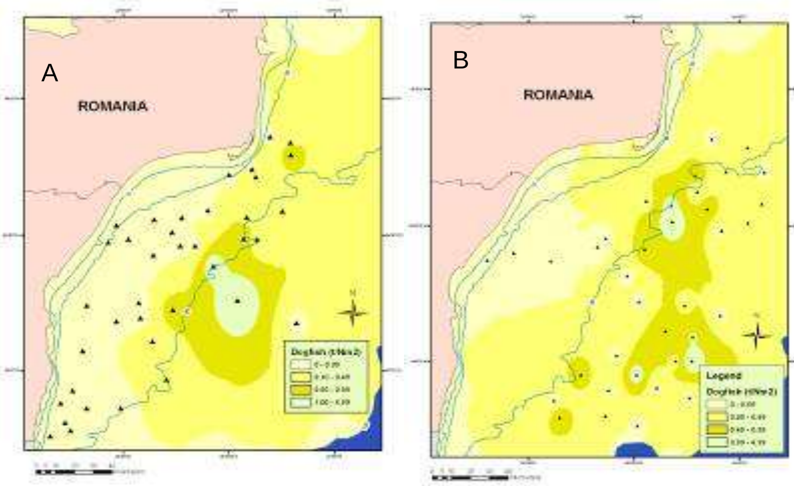


Fig. 6.6.3.1.1.3 Distribution of piked dogfish catches during demersal trawl survey in 2011 (A - spring season. B - autumn season), Romanian Black Sea area.

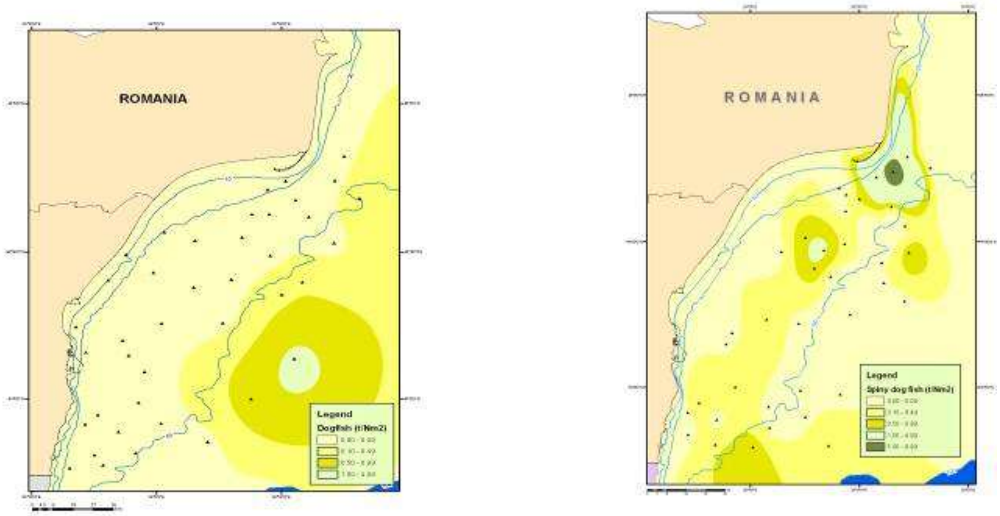


Fig: 6.6.3.1.1.4 The distribution of the dogfish agglomerations in demersal trawl survey, in May and October 2012, Romanian area

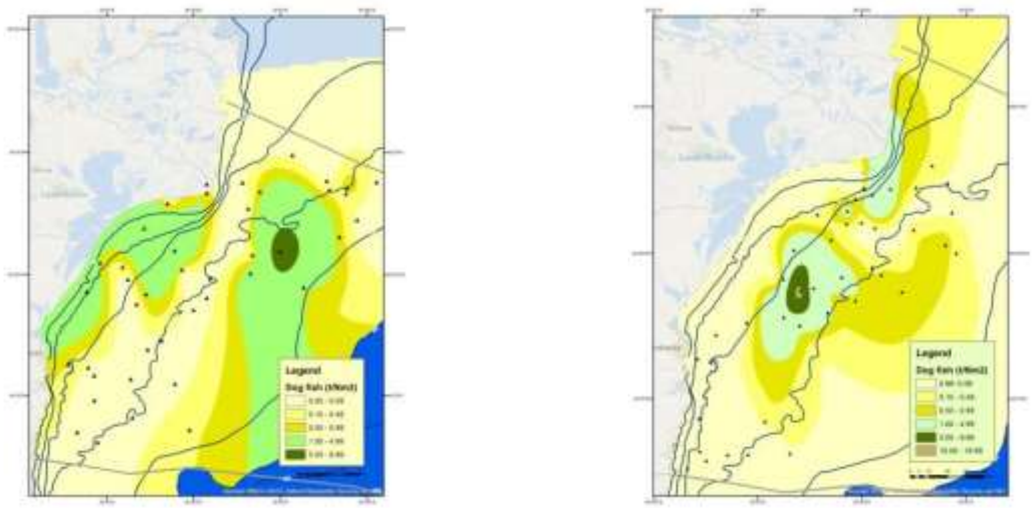


Fig: 6.6.3.1.1.5 The distribution of the dogfish agglomerations in demersal trawl survey, in May and October 2013, Romanian area

6.6.3.1.2 Trends in abundance at length or age

In the former USSR and later in Ukraine, to assess the piked dogfish stock, the swept area technique using bottom trawl surveys, as well as dynamic model of an isolated population, were applied (Shlyakhov, 1997). The abundance and biomass of piked dogfish in the waters adjacent to Georgia, the Russian Federation and Ukraine were assessed. The whole population of piked dogfish in 1972 – 1992 was assessed by VPA. The obtained results from stock assessments for whole Black Sea (Prodanov *et al.*, 1997, Daskalov 1998, Fig. 6.6.3.1.2.1), the former USSR and Ukrainian waters (Shlyakhov, Charova, 2006) in 1989 – 2005 are given in Table 6.6.3.1.2.2. According to the assessments, in 1989 – 2005 the stock of piked dogfish in the shelf area of the Black Sea and in Ukraine waters tends to be gradually reduced. Observed dynamics of stock corresponds with increasing CPUE in Turkish waters.

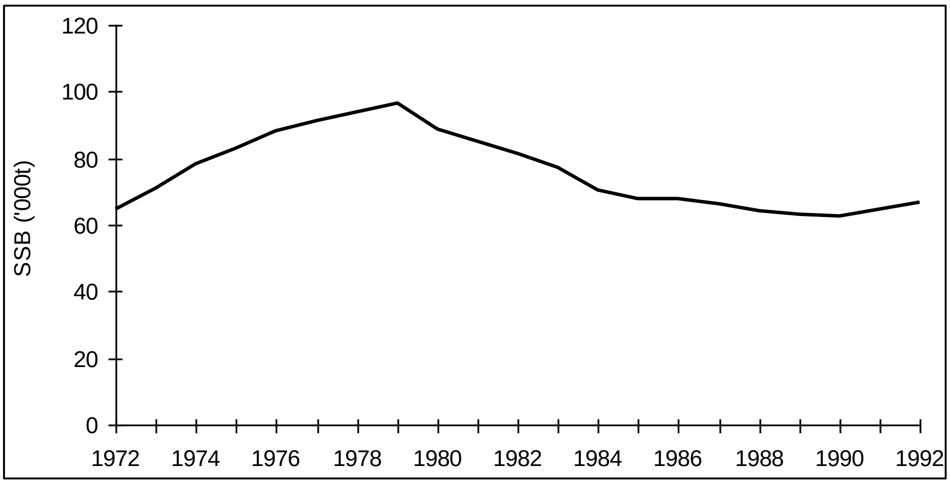


Fig. 6.6.3.1.2.1 Historical assessment of SSB by Daskalov (1998)

Table 6.6.3.1.2.1 Commercial stock of picked dogfish in the Black Sea and along the coast of the former USSR and in the water of Ukraine, x1000 tons.

Years	Whole Black Sea shelf	Waters of Ukraine, the Russian Federation and Georgia		Waters of Ukraine	
	VPA	Trawl survey	Modeling	Trawl survey	Modeling
1989	117.8	58.5	63.5	34.6	-
1990	112.9	58.7	63.2	48.8	-
1991	97.9	17.2/69.9*	64.0	14.4/58.5*	-
1992	90.0	62.9	60.3	56.9	-
1993	-	-	57.1	30.2	-
1994	-	-	52.9	36.0	42.1
1995	-	-	-	-	37.6
1996	-	-	-	-	32.1
1997	-	-	-	-	31.0
1998	-	-	-	32.0	30.8
1999	-	-	-	-	28.0
2000	-	-	-	-	24.3
2001	-	-	-	-	22.3
2002	-	-	-	-	21.0
2003	-	-	-	-	22.1
2004	-	-	-	-	22.3
2005	-	-	-	-	21.0

* stock assessment is reduced to the average area of the registration (survey) zone.

According to the assessments of Prodanov *et al.* (1997) and Daskalov (1998) piked dogfish stock has increased until 1981, after that it began to decrease. The authors explained the increase in piked dogfish with the increased abundance of main food species (whiting, sprat, anchovy and horse mackerel), and its subsequent reduction partially with intensification of the dogfish fishery during the period 1979 – 1984.

In Romanian waters the swept area method was applied for stock assessment of piked dogfish. Results for estimated piked dogfish biomasses in May and November of 2009-2013 in Romanian waters are given in the following tables.

Table 6.6.3.1.2.2 Indices of abundance at length of the piked dogfish over the Romanian littoral

Year	Biomass (t)		Indice of abundance in number of individuals per length classes									
			2009		2010		2011		2012		2013	
2008	883											
2009	2509											
2010	13051											
2011	1690											
2012	1436											
2013	4483											
Year	**Abundance (No.ind.)**	**class (cm)**	**%**	**Abundance (thousands)**	**%**	**Abundance (thousands)**	**%**	**Abundance (thousands)**	**%**	**Abundance (thousands)**	**%**	**Abundance (thousands)**
2008	126068	35.5									0.78	127.846
2009	393840	38.5									1.57	200.901
2010	1748855	41.5									0.00	0
2011	266064	44.5									1.57	132.358
2012	226651	47.5									0.00	0
2013	1283342	50.5									0.00	0
		53.5									1.57	68.600
		56.6									0.00	0
		59.5									1.57	46.260
		62.5									0.00	0
		65.5									0.00	0
		68.5									0.00	0
		71.5									0.00	0
		74.5									0.00	0
		77.5									0.00	0
		80.5									0.00	0
		83.5									0.00	0
		86.6									0.00	0
		89.5			1.00	17.621					0.00	0
		92.5			0.00	0					0.00	0
		95.5			2.00	35.241					0.00	0
		98.5			2.99	52.862					0.00	0
		101.5			0.00	0	6.78	18.038	0.93	2.955	0.39	4.185
		104.5	1.93	7.601	0.50	8.810	8.48	22.548	0.0	0.0	1.57	15.801
		107.5	8.21	32.334	7.98	140.966	16.95	45.096	2.78	7.540	6.27	56.692
		110.5	14.98	58.997	16.46	290.742	28.81	76.663	10.19	26.683	10.20	86.733
		113.5	19.8	78.020	23.44	414.087	25.42	67.643	34.26	80.033	26.67	209.946

			1									
		116.6	27.05	106.634	17.71	312.768	8.48	22.548	27.78	61.020	20.78	155.348
		119.5	16.43	64.708	9.73	171.802	3.39	9.019	8.33	17.464	16.47	116.092
		122.5	7.24	28.514	4.49	79.293	0.00	0	14.81	29.453	8.24	52.704
		125.5	1.93	7.601	2.99	52.862	1.70	4.510	0.93	1.602	0.39	2.388
		128.5	0	0	8.73	154.181					0.00	0
		131.5	1.45	5.711	2.00	35.241					0.39	1.870
		134.5									0.39	1.749
		137.5	0.97	3.820							0.00	0
		140.5									0.39	1.450
		143.5									0.00	0
		146.6									0.78	2515
		Total	**100.0**	**393.840**	**100.0**	**1748.855**	**100.0**	**266.064**	**100.0**	**226651**	**100**	1283.342

Table 6.6.3.1.2.3 The biomass at length of the piked dogfish over the Romanian littoral.

BIOMASS (t)										
	2009		**2010**		**2011**		**2012**		**2013**	
class (cm)	**%**	**Biomass (t)**	**%**	**Biomass (t)**	**%**	**Biomass (t)**	**%**	**Biomass (t)**	**%**	**Biomass (t)**
35.5									0.78	35.158
38.5									1.57	70.315
41.5									0.00	0
44.5									1.57	70.315
47.5									0.00	0
50.5									0.00	0
53.5									1.57	70.315
56.6									0.00	0
59.5									1.57	70.315
62.5									0.00	0
65.5									0.00	0
68.5									0.00	0
71.5									0.00	0
74.5									0.00	0
77.5									0.00	0
80.5									0.00	0
83.5									0.00	0
86.6									0.00	0
89.5			0.41	52.86					0.00	0
92.5			0.00	0.00					0.00	0
95.5			0.91	118.50					0.00	0
98.5			1.54	201.36					0.00	0
101.5			0.00	0.00	6.48	109.833851	0.93	13.296296	0.39	17.579
104.5	1.27	31.86	0.30	38.59	7.65	129.816526	0.0	0.0	1.57	70.315
107.5	6.74	169.08	5.32	693.93	15.37	260.719579	2.78	39.888889	6.27	281.262
110.5	13.80	346.17	12.82	1673.05	28.31	480.198320	10.19	146.259259	10.20	457.050
113.5	19.07	478.47	19.98	2607.85	26.83	454.971965	34.26	491.962963	26.67	1195.362
116.6	27.13	680.81	16.97	2214.86	9.27	157.145078	27.78	398.888889	20.78	931.680
119.5	17.27	433.30	10.52	1372.70	4.00	67.884406	8.33	119.666667	16.47	738.312
122.5	8.43	211.57	6.18	806.90	0.00	0.000000	14.81	212.740741	8.24	369.156

125.5	2.28	57.19	5.02	655.49	2.09	35.430275	0.93	13.296296	0.39	17.579
128.5	0.00	0.00	15.99	2087.18					0.00	0
131.5	1.90	47.57	4.04	527.74					0.39	17.579
134.5	0.00	0.00	0.00	0.00					0.39	17.579
137.5	2.11	52.94	0.00	0.00					0.00	0
140.5									0.39	17.579
143.5									0.00	0
146.6									0.78	35.158
Total	**100**	**2508.97**	**100**	**13051.0**	**100**	**1690.000**	**100**	**1436.000**	**100**	**4482.609**

6.6.3.1.3 Trends in growth

The EWG 14-14 have been provided with data for the last years by Romania

Parameters	**2011**	**2012**	**2013**
Linf	136	157	156
a	0.0117	0.0169769	0.061086
b	2.7694	2.696436	2.41368
k	0.191	0.153	0.134
to	-1.31	-1.13684	-0.9304
M	0.258	0.15	0.22

6.6.3.1.4 Trends in maturity

In 2013, in Romanian waters only males were found. In the previous year (2012), in Bulgarian waters, the majority of the piked dogfish were females.

Table 6.6.3.1.4.1 Age at first maturation and massive maturation (Romanian data)

Species	Age at first maturation	Age for massive maturation
Dogfish	male = 4- 5 years; female = 7 – 8 years	6-7 years

Table 6.6.3.1.4.2..Maturity ogive from Romanian data

Age	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
%	0.0	0.0	0.45	0.7	0.95	1.0	1.0	1.0	1.00	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

6.6.3.1.5 Abundance and biomass

In Romanian waters the swept area method was applied for stock assessment of piked dogfish. Results for estimated piked dogfish biomasses in May and November of 2009- 2011 in Romanian waters are given on Tab. 6.6.3.1.5.1 - 6.6.3.1.5.2 (Maximov et al.2010b.c; Radu et al. 2009 a.b. 2010a.b). In May 2009 the biomass of dogfish was evaluated at 741 t. extrapolated to 967 t for the shelf till 50 Nm from the shore. In May 2010 the biomass of dogfish was evaluated at 2437 t. extrapolated to 5635 t for the shelf till 50 Nm from the shore. In the autumn period the biomass agglomeration increased at 2541 t (2009) and 13051 tons (2010).

Table 6.6.3.1.5.1. Results for estimated piked dogfish biomasses in May and November of 2009- 2013 in Romanian waters

Species	2009	2010	2011	2012	2013
Piked dogfish	967-2,541	5,635-13,051	1,173-1,619	1,436-1,159	3,181-4,482

The calculated biomasses in the Romanian littoral zone ranged between 967 t and 13,051 t.

Table 6.6.3.1.5.2 Assessment of piked dogfish biomass in May 2009 by demersal trawl. Romanian Black Sea area.

No. polygon	Surveyed area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total t in polygon (t)	Notes
1	1.227.13	0.00	0.00	0.0	Extrapolated at 967 t for the shelf till 50 Nm from shore
2	242.25	0.27 – 0.43	0.35	84.78	
3	165.00	0.23 – 0.28	0.26	42.90	
4	116.00	0.28	0.28	32.48	
5	724.25	0.53 0.76	0.63	456.27	
6	478.25	0.23 – 0.28	0.26	124.35	
7	265.63	0.00	0.0	0.00	
Total	3.218.5			740.78	

Table 6.6.3.1.5.3 Assessment of dogfish agglomeration in the Romanian area in the period May –June 2010. sampling gear demersal trawl

No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon(t)	Total on the shelf (t)
1	630.50	0.00	0.00	0.00	Extrapolated at 5635 tons for the shelf till 50 Nm from shore (about 5000 Nm2). including the new area (near Snake Island)
2	567.75	0.21-1.41	0.63	357.68	
3	216.75	0.24-0.68	0.47	101.87	
4	1155.00	0.56-5.62	2.11	2437.00	
Total	2570			2897.00	

Table 6.6.3.1.5.4. Assessment of picked dogfish biomass by demersal trawl in November 2009. Romanian Black Sea area.

No. polygon	Surveyed Area(Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total t in polygon (t)	Notes
1	926.25	0.26 – 0.81	0.41	379.76	Extrapolated at 2.541 t for the shelf till 50 Nm from shore
2	2.404.13	0.39 – 2.04	0.68	1.634.81	
Total	**3.330**			**2.015**	

Table 6.6.3.1.5.5 Assessment of dogfish agglomeration in the Romanian area in the period October – November 2010. sampling gear demersal trawl

No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon(t)	Total on the shelf (t)
1	40	164.48	164.48	6579.2	Extrapolated at 13051 tons for the shelf till 50 Nm from shore (about 5000 Nm2). including the new area (near Snake Island)
2	56	5.82	5.82	325.9	
3	1201	0.00-0.89	0.46	552.5	
4	315	0.00	0.00	0.00	

5	570	0.00	0.00	0.00	
6	868	0.28-1.01	0.58	503.44	
TOTAL	**3050**			**7961.04**	

Table 6.6.3.1.5.6 Assessment of dogfish agglomeration in the Romanian area in the spring 2011. sampling gear demersal trawl

Range of depths (m)	0 - 30	30-50	50-70	Total
Area (Nm^2)	675	1050	500	2225
Range of t/ Nm^2	0.00 – 0.00	0.00 – 1.11	0.00 – 2.53	
Biomass (t)	00.00	205.8	316	522.3*

* extrapolated at 1173 tons

Table 6.6.3.1.5.7 Assessment of dogfish agglomeration in the Romanian area in the autumn 2011. sampling gear demersal trawl

Range of depths (m)	0 - 30	30-50	50-70	Total
Area (Nm^2)	650	1225	1700	3575
Range of t/ Nm^2	0.00 – 0.00	0.00 – 1.53	0.00 – 2.53	
Biomass (t)	00.00	561.86	650.969	1212.8

* extrapolated at 1696 tons

Table 6.6.3.1.5.8 Assessment of dogfish agglomerations in the period May 2012, demersal trawl survey , Romanian area

Depth range (m)	0 - 30m	30 – 50m	50-70 m	Total
Investigated area (Nm^2)	663.62	1065	517.37	2245.99
Variation of the catches (t/ Nm^2)	0.00-0.062	0.00-0.365	0.00-0.75	0.00-0.75
Average catch (t/ Nm^2)	0.005	0.016	0.432	
Biomass of the fishing agglomerations (t)	3.468	17.69	223.81	244.97
Biomass extrapolated the Romanian shelf (t)				1436.34

Table 6.6.3.1.5.9 Assessment of dog fish agglomerations in the period October - November 2012, pelagic trawl survey , Romanian area

Depth range (m)	0 - 30m	30 – 50m	50-70 m	Total
Investigated area (Nm^2)	754.58	1294.12	807	2855.7
Variation of the catches (t/ Nm^2)	0.30-1.35	0.00-1.60	0.00-0.86	0.00-1.60
Average catch (t/ Nm^2)	0.736	0.372	0.161	
Biomass of the fishing agglomerations (t)	754.85	482.324	130.53.4	1169.086
Biomass extrapolated the Romanian shelf (t)				1515.883

Table 6.6.3.1.5.10 Assessment of dogfish agglomerations in the period May –June 2013, demersal trawl survey , Romanian area

Depth range (m)	0 - 30m	30 – 50m	50-70 m	70-100m	Total
Investigated area (Nm^2)	650	1225	1350	50	3300
Variation of the catches (t/ Nm^2)	0.325-2.264	0.00-4.272	0.00-6.878	0.013-0.019	0.00-6.878
Average catch (t/ Nm^2)	1.19033	0.530778	0.607833	0.015583	0.63622
Biomass of the fishing agglomerations	773.7167	650.2028	820.575	1.16875	2099.53

(t)					
Biomass extrapolated the Romanian shelf (t)					3181.119

Table 6.6.3.1.5.11 Assessment of dogfish agglomerations in October 2013, demersal trawl survey, Romanian area

Depth range (m)	0 - 30m	30 – 50m	50-70 m	Total
Investigated area (Nm^2)	625	1075	450	2150
Variation of the catches (t/ Nm^2)	0.00-0.308	0.00-11.404	0.00-1.32	0.00-11.40
Average catch (t/ Nm^2)	0.060333	1.5042	0.386714	0.896522
Biomass of the fishing agglomerations (t)	37.70833	1617.015	174.0214	1927.522
Biomass extrapolated the Romanian shelf (t)				4482.609

6.6.4 Assessment of historical parameters

6.6.4.1 Method

EWG14-14 applied two methods: VIT as in previous years and for the first time XSA.

6.6.4.2 Justification

EWG 14-14 used the VIT program for estimation of abundance and fishing mortality and YPR-LEN (NOAA Fisheries Toolbox Version 3.1) for obtaining the reference points for dogfish in the Black Sea.

The program VIT is conceived for the analysis of fisheries where the available information is limited. VIT is designed for the analysis of marine populations, exploited by one or several gears, based on single species' catch data (structured by age or size). The main assumption underlying the model is that of steady state, because the program works with pseudo-cohorts and it is therefore not suitable for historical data series.

The program uses the catch data and ancillary parameters for rebuilding the population of the species and the mortality vectors affecting it by means of Virtual Population Analysis (VPA). Once the virtual population has been rebuilt, an analysis of the fishery can be carried out with the aid of several tools: Comprehensive VPA results, Yield-per-Recruit analysis based on the fishing mortality vector, analysis of sensitivity to parameter values and transition analysis. The latter permits non-equilibrium analysis of how a shift in exploitation regime is reflected in the fisheries. All these tools can be applied to specific studies of competition among fishing gears.

To compare results, XSA has been also applied. For the sake of consistency, the piked dogfish stock was first assessed quantitatively by XSA. The model was tuned with the CPUE at age derived from the Romanian scientific demersal surveys realised in the last three years (2011-2013).

6.6.4.3 Input parameters

For VIT, given the experience gained from previous studies, the piked dogfish can be assessed using age-structured methods (Prodanov et al. 1997, Shlyakhov, 1997, Daskalov 1998). Fisheries, biological (age and individual size and growth), trawl survey data and commercial CPUE from all countries need to be thoroughly compiled (Table 6.6.4.3.1).

At the first stage data must be carefully screened and organized into age structured matrices.
Romanian dogfish age/length keys have been used.

Table 6.6.4.3.1 Romanian dogfish age/length key

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length class (cm)	21-30	31-35	36-40	41-50	51-55	56-60	61-65	66-70	71-80	81-85	86-90	91-100	101-105	106-110	111-115	116-120	121-125	126-130	131-135	136-140	141-145

Linf =156 cm; k = 0.134; to = -0.9304; a = 0.061086; b= 2.41368
Ft =0.5 and Ft =0.15;
Number of classes = 9;
Lower limit of first class = 11;
Class interval = 1;
Fecundity = 1;
M= 0.15;

In the calculation we used two variants, the average catch of the past 25 years (1989-2013) and catch value from 2013. Also, we compared results with two values for Ft, 0.5 and 0.15.
Results are presented in the following pages.
For reference points, using YPR-LEN the following parameters have been used:
Length at start = 95 cm;
Maximum relative age = 19 cm;
Age step size = 1;
Linf =156 cm; k = 0.134; to = -0.9304; a = 0.061086; b= 2.41368
Maturity: Alpha = 106; Beta = 0.5

For XSA, the following input parameters have been used:

```
An object of class "FLStock"
Slot "catch":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1989     1990     1991     1992     1993     1994     1995     1996
  all 6159.066 2761.342 2924.171 2911.124 1618.019 2650.527 1836.960 1950.854
     year
age   1997     1998     1999     2000     2001     2002     2003     2004
  all 1585.398 1482.224 1628.968 2601.601  894.976  601.511  452.422  421.445
     year
age   2005     2006     2007     2008     2009     2010     2011     2012
  all  250.849  302.581  211.036  206.385  235.251   74.992  104.268   77.824
     year
age   2013
  all   83.219

units:  NA NA

Slot "catch.n":
An object of class "FLQuant"
```

, , unit = unique, season = all, area = unique

age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
7	5.77	2.55	2.72	2.69	1.51	2.49	1.65	1.78	1.46	1.37
8	24.32	10.76	11.47	11.34	6.38	10.51	6.98	7.50	6.14	5.78
9	26.85	11.88	12.66	12.51	7.04	11.60	7.70	8.28	6.78	6.38
10	73.69	32.61	34.75	34.35	19.33	31.84	21.14	22.73	18.60	17.50
11	101.44	44.89	47.84	47.29	26.60	43.83	29.10	31.29	25.61	24.09
12	89.64	40.06	42.49	42.22	23.54	38.61	26.48	28.21	22.96	21.50
13	121.37	54.22	57.52	57.15	31.87	52.28	35.82	38.17	31.07	29.10
14	101.13	47.42	49.17	50.16	26.73	42.86	34.32	35.05	27.82	25.47
15	107.77	49.68	51.92	52.48	28.42	45.94	34.87	36.12	28.91	26.68
16	139.63	62.01	65.96	65.33	36.63	60.26	40.47	43.38	35.43	33.28
17	80.70	35.81	38.11	37.72	21.17	34.84	23.33	25.03	20.45	19.22
18	30.45	13.48	14.36	14.19	7.99	13.16	8.73	9.39	7.69	7.23
19	7.75	3.43	3.65	3.61	2.03	3.35	2.22	2.39	1.96	1.84

age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
7	1.51	2.36	0.72	0.67	0.01	0.71	1.03	0.01	0.01	0.01
8	6.38	9.94	3.05	4.02	0.01	2.12	3.11	2.41	0.01	0.01
9	7.04	10.97	3.36	10.36	0.01	2.20	1.03	2.48	0.73	0.01
10	19.31	30.13	9.23	17.13	0.24	0.46	0.01	4.89	1.46	0.01
11	26.59	41.47	12.70	21.48	0.54	0.01	0.01	19.56	1.46	0.01
12	23.66	37.56	12.58	22.44	4.66	0.01	0.01	14.67	2.92	0.96
13	32.02	50.81	16.97	19.79	11.05	0.12	1.03	12.19	5.84	2.92
14	27.62	47.63	22.00	12.44	12.18	0.79	4.14	2.48	5.11	1.94
15	29.08	48.74	20.46	4.27	12.96	3.16	9.30	0.01	2.92	2.92
16	36.68	57.58	18.23	1.32	5.61	5.57	8.28	2.41	5.11	5.82
17	21.19	33.21	10.44	0.27	6.99	8.72	3.14	2.41	2.19	4.84
18	7.98	12.45	3.81	0.01	4.96	11.76	1.03	0.01	1.46	1.94
19	2.03	3.17	0.97	0.01	0.54	5.94	0.01	0.01	0.01	0.96

age	2009	2010	2011	2012	2013
7	0.01	0.09	0.10	0.04	0.01
8	0.01	0.39	0.42	0.16	0.01
9	2.60	0.43	0.46	0.17	0.01
10	13.83	1.18	1.26	0.48	0.01
11	10.06	1.63	1.73	0.66	0.53
12	5.89	1.43	1.52	0.62	1.07
13	5.59	1.94	2.06	0.91	1.60
14	5.25	1.56	1.65	2.77	2.14
15	2.89	1.68	1.79	2.42	2.67
16	2.01	2.24	2.38	1.62	1.07
17	0.93	1.29	1.38	0.57	0.53
18	0.01	0.49	0.52	0.20	0.53
19	0.01	0.12	0.13	0.05	0.53

units: NA

```
Slot "catch.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age  1989  1990  1991  1992  1993  1994  1995  1996  1997  1998  1999  2000
  7   1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48
  8   1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90
  9   2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40
  10  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00
  11  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73
  12  4.58  4.59  4.58  4.59  4.58  4.57  4.60  4.59  4.59  4.59  4.58  4.60
  13  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72
  14  7.01  6.94  6.97  6.94  7.00  7.03  6.82  6.88  6.91  6.94  6.96  6.85
  15  8.28  8.21  8.24  8.20  8.27  8.31  8.07  8.13  8.17  8.21  8.23  8.10
  16  9.77  9.76  9.77  9.76  9.77  9.78  9.74  9.75  9.76  9.76  9.76  9.75
  17 11.01 11.00 11.01 11.00 11.01 11.02 10.99 10.99 11.00 11.00 11.01 10.99
  18 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33
  19 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71
   year
age  2001  2002  2003  2004  2005  2006  2007  2008  2009  2010  2011  2012
  7   1.48  1.71  1.60  1.48  1.48  1.41  1.35  1.35  1.35  1.35  1.48  1.48
  8   1.90  2.20  2.05  1.90  1.90  1.90  1.77  1.65  1.65  1.65  1.90  1.90
  9   2.40  2.77  2.59  2.40  2.40  2.40  2.40  2.40  2.40  2.01  2.40  2.40
  10  3.00  3.47  2.82  3.00  3.00  3.00  3.00  3.00  3.00  2.45  3.00  3.00
  11  3.73  4.32  3.50  3.62  3.73  3.73  3.73  3.73  3.73  2.98  3.73  3.86
  12  4.67  5.28  4.29  4.43  4.56  4.56  4.57  4.57  4.56  3.59  4.57  4.58
  13  5.71  6.61  5.37  5.72  5.71  5.71  5.72  5.71  5.71  4.42  5.72  5.76
  14  6.51  8.16  6.63  7.06  7.05  7.05  7.06  7.05  7.05  5.39  7.06  7.65
  15  7.64  9.64  7.83  8.34  8.33  8.33  8.34  8.33  8.33  6.32  8.34  7.74
  16  9.64 11.31  9.18  9.78  9.77  9.77  9.78  9.77  9.77  7.36  9.78  9.89
  17 10.90 12.74 10.35 11.02 11.01 11.01 11.02 11.01 11.01  8.26 11.02 10.30
  18 12.33 11.95 11.58 12.33 12.32 12.32 12.33 12.32 10.76  9.21 12.33 12.41
  19 13.71 13.29 12.87 13.71 13.70 13.70 13.70 13.70 11.95 10.21 13.71 13.75
   year
age  2013
  7   1.48
  8   1.90
  9   2.40
  10  3.00
  11  4.00
  12  4.60
  13  5.80
  14  7.00
  15  8.00
  16 10.00
  17 11.00
  18 12.50
```

```
 19 13.80

units:  NA

Slot "discards":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age   1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002
  all 0    0    0    0    0    0    0    0    0    0    0    0    0    0
    year
age   2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
  all 0    0    0    0    0    0    0    0    0    0    0

units:  NA

Slot "discards.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age  1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
  7  0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  8  0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  9  0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  10 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  11 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  12 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  13 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  14 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  15 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  16 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  17 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  18 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  19 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   year
age  2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
  7  0    0    0    0    0    0    0    0    0    0
  8  0    0    0    0    0    0    0    0    0    0
  9  0    0    0    0    0    0    0    0    0    0
  10 0    0    0    0    0    0    0    0    0    0
  11 0    0    0    0    0    0    0    0    0    0
  12 0    0    0    0    0    0    0    0    0    0
  13 0    0    0    0    0    0    0    0    0    0
  14 0    0    0    0    0    0    0    0    0    0
  15 0    0    0    0    0    0    0    0    0    0
  16 0    0    0    0    0    0    0    0    0    0
  17 0    0    0    0    0    0    0    0    0    0
```

```
  18 0   0   0   0   0   0   0   0   0   0
  19 0   0   0   0   0   0   0   0   0   0

units:  NA

Slot "discards.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age  1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
  7  0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  8  0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  9  0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  10 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  11 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  12 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  13 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  14 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  15 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  16 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  17 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  18 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  19 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    year
age  2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
  7  0    0    0    0    0    0    0    0    0    0
  8  0    0    0    0    0    0    0    0    0    0
  9  0    0    0    0    0    0    0    0    0    0
  10 0    0    0    0    0    0    0    0    0    0
  11 0    0    0    0    0    0    0    0    0    0
  12 0    0    0    0    0    0    0    0    0    0
  13 0    0    0    0    0    0    0    0    0    0
  14 0    0    0    0    0    0    0    0    0    0
  15 0    0    0    0    0    0    0    0    0    0
  16 0    0    0    0    0    0    0    0    0    0
  17 0    0    0    0    0    0    0    0    0    0
  18 0    0    0    0    0    0    0    0    0    0
  19 0    0    0    0    0    0    0    0    0    0

units:  NA

Slot "landings":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002
  all 6159 2761 2924 2911 1618 2650 1837 1951 1585 1482 1629 2601  895  602
```

```
    year
age   2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
  all  452  421  251  302  211  206  235   75  104   70   83

units:  NA

Slot "landings.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age  1989   1990   1991   1992   1993   1994   1995   1996   1997   1998
  7    5.77   2.55   2.72   2.69   1.51   2.49   1.65   1.78   1.46   1.37
  8   24.32  10.76  11.47  11.34   6.38  10.51   6.98   7.50   6.14   5.78
  9   26.85  11.88  12.66  12.51   7.04  11.60   7.70   8.28   6.78   6.38
  10  73.69  32.61  34.75  34.35  19.33  31.84  21.14  22.73  18.60  17.50
  11 101.44  44.89  47.84  47.29  26.60  43.83  29.10  31.29  25.61  24.09
  12  89.64  40.06  42.49  42.22  23.54  38.61  26.48  28.21  22.96  21.50
  13 121.37  54.22  57.52  57.15  31.87  52.28  35.82  38.17  31.07  29.10
  14 101.13  47.42  49.17  50.16  26.73  42.86  34.32  35.05  27.82  25.47
  15 107.77  49.68  51.92  52.48  28.42  45.94  34.87  36.12  28.91  26.68
  16 139.63  62.01  65.96  65.33  36.63  60.26  40.47  43.38  35.43  33.28
  17  80.70  35.81  38.11  37.72  21.17  34.84  23.33  25.03  20.45  19.22
  18  30.45  13.48  14.36  14.19   7.99  13.16   8.73   9.39   7.69   7.23
  19   7.75   3.43   3.65   3.61   2.03   3.35   2.22   2.39   1.96   1.84
    year
age  1999   2000   2001   2002   2003   2004   2005   2006   2007   2008
  7    1.51   2.36   0.72   0.67   0.01   0.71   1.03   0.01   0.01   0.01
  8    6.38   9.94   3.05   4.02   0.01   2.12   3.11   2.41   0.01   0.01
  9    7.04  10.97   3.36  10.36   0.01   2.20   1.03   2.48   0.73   0.01
  10  19.31  30.13   9.23  17.13   0.24   0.46   0.01   4.89   1.46   0.01
  11  26.59  41.47  12.70  21.48   0.54   0.01   0.01  19.56   1.46   0.01
  12  23.66  37.56  12.58  22.44   4.66   0.01   0.01  14.67   2.92   0.96
  13  32.02  50.81  16.97  19.79  11.05   0.12   1.03  12.19   5.84   2.92
  14  27.62  47.63  22.00  12.44  12.18   0.79   4.14   2.48   5.11   1.94
  15  29.08  48.74  20.46   4.27  12.96   3.16   9.30   0.01   2.92   2.92
  16  36.68  57.58  18.23   1.32   5.61   5.57   8.28   2.41   5.11   5.82
  17  21.19  33.21  10.44   0.27   6.99   8.72   3.14   2.41   2.19   4.84
  18   7.98  12.45   3.81   0.01   4.96  11.76   1.03   0.01   1.46   1.94
  19   2.03   3.17   0.97   0.01   0.54   5.94   0.01   0.01   0.01   0.96
    year
age  2009   2010   2011   2012   2013
  7    0.01   0.09   0.10   0.04   0.01
  8    0.01   0.39   0.42   0.16   0.01
  9    2.60   0.43   0.46   0.17   0.01
  10  13.83   1.18   1.26   0.48   0.01
  11  10.06   1.63   1.73   0.66   0.53
  12   5.89   1.43   1.52   0.62   1.07
  13   5.59   1.94   2.06   0.91   1.60
```

```
  14  5.25  1.56  1.65  2.77  2.14
  15  2.89  1.68  1.79  2.42  2.67
  16  2.01  2.24  2.38  1.62  1.07
  17  0.93  1.29  1.38  0.57  0.53
  18  0.01  0.49  0.52  0.20  0.53
  19  0.01  0.12  0.13  0.05  0.53

units:  NA

Slot "landings.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age  1989  1990  1991  1992  1993  1994  1995  1996  1997  1998  1999  2000
  7   1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48
  8   1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90
  9   2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40
  10  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00
  11  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73
  12  4.58  4.59  4.58  4.59  4.58  4.57  4.60  4.59  4.59  4.59  4.58  4.60
  13  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72
  14  7.01  6.94  6.97  6.94  7.00  7.03  6.82  6.88  6.91  6.94  6.96  6.85
  15  8.28  8.21  8.24  8.20  8.27  8.31  8.07  8.13  8.17  8.21  8.23  8.10
  16  9.77  9.76  9.77  9.76  9.77  9.78  9.74  9.75  9.76  9.76  9.76  9.75
  17 11.01 11.00 11.01 11.00 11.01 11.02 10.99 10.99 11.00 11.00 11.01 10.99
  18 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33
  19 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71
    year
age  2001  2002  2003  2004  2005  2006  2007  2008  2009  2010  2011  2012
  7   1.48  1.71  1.60  1.48  1.48  1.41  1.35  1.35  1.35  1.35  1.48  1.48
  8   1.90  2.20  2.05  1.90  1.90  1.90  1.77  1.65  1.65  1.65  1.90  1.90
  9   2.40  2.77  2.59  2.40  2.40  2.40  2.40  2.40  2.40  2.01  2.40  2.40
  10  3.00  3.47  2.82  3.00  3.00  3.00  3.00  3.00  3.00  2.45  3.00  3.00
  11  3.73  4.32  3.50  3.62  3.73  3.73  3.73  3.73  3.73  2.98  3.73  3.86
  12  4.67  5.28  4.29  4.43  4.56  4.56  4.57  4.57  4.56  3.59  4.57  4.58
  13  5.71  6.61  5.37  5.72  5.71  5.71  5.72  5.71  5.71  4.42  5.72  5.76
  14  6.51  8.16  6.63  7.06  7.05  7.05  7.06  7.05  7.05  5.39  7.06  7.65
  15  7.64  9.64  7.83  8.34  8.33  8.33  8.34  8.33  8.33  6.32  8.34  7.74
  16  9.64 11.31  9.18  9.78  9.77  9.77  9.78  9.77  9.77  7.36  9.78  9.89
  17 10.90 12.74 10.35 11.02 11.01 11.01 11.02 11.01 11.01  8.26 11.02 10.30
  18 12.33 11.95 11.58 12.33 12.32 12.32 12.33 12.32 10.76  9.21 12.33 12.41
  19 13.71 13.29 12.87 13.71 13.70 13.70 13.70 13.70 11.95 10.21 13.71 13.75
    year
age  2013
  7   1.48
  8   1.90
  9   2.40
  10  3.00
```

```
 11  4.00
 12  4.60
 13  5.80
 14  7.00
 15  8.00
 16 10.00
 17 11.00
 18 12.50
 19 13.80

units:  NA

Slot "stock":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002
  all 0    0    0    0    0    0    0    0    0    0    0    0    0    0
     year
age   2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
  all 0    0    0    0    0    0    0    0    0    0    0

units:  NA * NA

Slot "stock.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age  1989       1990       1991       1992       1993       1994
  7  888.491573 838.206933 757.780614 672.467789 658.086788 448.027289
  8  862.741147 759.378704 719.085647 649.704356 576.302760 565.019655
  9  778.026244 720.005465 643.620788 608.281534 548.685111 490.109379
  10 734.973840 644.743481 608.692855 542.224313 511.946697 465.726337
  11 677.750529 564.232429 524.682142 491.667709 434.828803 422.703324
  12 561.167911 489.234987 443.992947 407.214856 379.309329 349.582642
  13 507.550490 399.838771 383.923051 342.728450 311.323745 304.635484
  14 406.458366 324.252528 293.842168 277.081827 241.968570 238.391646
  15 323.063555 256.019259 235.093142 207.295150 191.950926 183.465695
  16 266.467567 178.080463 174.267522 154.178100 129.732611 138.847223
  17 151.025844  99.809937  95.745902  88.799486  72.092839  77.678649
  18  77.325129  55.120250  52.684715  47.052957  41.435941  42.410552
  19  19.527709  13.958936  13.320931  11.900901  10.487144  10.731381
    year
age  1995       1996       1997       1998       1999       2000
  7  356.877470 335.432047 247.088513 151.801686 108.069396 273.746152
  8  383.310580 305.636509 287.057655 211.316548 129.385913  91.615298
  9  476.566340 323.442824 256.105705 241.376469 176.519481 105.444484
```

10	411.079227	403.040825	270.708103	214.142122	201.835648	145.400411
11	371.315021	334.206672	325.812844	215.744595	168.078321	155.806826
12	323.161126	292.596464	258.625255	256.670203	163.343753	119.997653
13	265.068392	253.580711	225.668467	201.299829	200.971606	118.640860
14	213.699761	194.914708	182.846972	165.409660	146.263033	143.271518
15	165.422505	152.092933	135.247235	131.568023	118.739787	100.265484
16	115.289852	110.030054	97.397506	89.587310	88.489451	75.221501
17	63.601090	61.685116	54.458233	50.960858	46.233209	42.133945
18	34.536050	33.097710	29.871452	27.900281	26.031187	20.134407
19	8.739429	8.378177	7.575660	7.064946	6.582826	5.053616

year

age	2001	2002	2003	2004	2005	2006
7	91.547772	95.720334	55.577479	52.370064	65.970223	82.640840
8	233.426021	78.127923	81.765667	47.826702	44.416634	55.825521
9	69.632248	198.082021	63.515797	70.367084	39.198008	35.344469
10	80.579562	56.815813	160.879353	54.659276	58.524475	32.782462
11	97.194383	60.792400	33.009578	138.247484	46.618913	50.363205
12	95.630655	71.873638	32.396573	27.910625	118.981435	40.115993
13	68.436891	70.639055	41.043650	23.560704	24.013620	102.398992
14	54.976488	43.160371	42.439554	25.075031	20.167557	19.713139
15	79.126516	26.908345	25.607347	25.228147	20.849362	13.517519
16	41.081085	49.123192	19.198763	10.016892	18.782398	9.317198
17	11.324276	18.446054	41.056101	11.319887	3.454088	8.484444
18	5.454662	0.061253	15.626175	28.852387	1.653194	0.059846
19	1.364251	0.061048	1.690812	14.455657	0.015819	0.059642

year

age	2007	2008	2009	2010	2011	2012
7	43.854158	63.191468	70.480219	67.313800	59.268566	60.909216
8	71.120352	37.736346	54.380123	60.653609	57.854028	50.920153
9	45.813610	61.204577	32.470697	46.796128	51.843225	49.405771
10	28.120462	38.754887	52.669990	25.535655	39.878871	44.195116
11	23.679461	22.849001	33.347363	32.502788	20.884004	33.155106
12	25.201350	19.026596	19.657040	19.369241	26.463187	16.370033
13	20.918158	18.981992	15.485709	11.454562	15.344587	21.366906
14	76.826436	12.586403	13.628941	8.142587	8.059210	11.296057
15	14.666452	61.384357	9.033395	6.859885	5.561110	5.405850
16	11.625359	9.914521	50.124995	5.093937	4.345748	3.125831
17	5.783525	5.265270	3.134040	41.278219	2.306247	1.532391
18	5.066767	2.946168	0.041581	1.834692	34.331703	0.704719
19	0.034511	1.434832	0.041387	0.446997	8.573121	0.175216

year

age	2013
7	66.359395
8	52.387938
9	43.678943
10	42.366225
11	37.593772
12	27.924553
13	13.514617

```
  14  17.546420
  15   7.152757
  16   2.407719
  17   1.187483
  18   0.790127
  19   0.777210

units:  NA

Slot "stock.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age  1989  1990  1991  1992  1993  1994  1995  1996  1997  1998  1999  2000
  7   1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48  1.48
  8   1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90  1.90
  9   2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40  2.40
  10  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00  3.00
  11  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73  3.73
  12  4.58  4.59  4.58  4.59  4.58  4.57  4.60  4.59  4.59  4.59  4.58  4.60
  13  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72  5.72
  14  7.01  6.94  6.97  6.94  7.00  7.03  6.82  6.88  6.91  6.94  6.96  6.85
  15  8.28  8.21  8.24  8.20  8.27  8.31  8.07  8.13  8.17  8.21  8.23  8.10
  16  9.77  9.76  9.77  9.76  9.77  9.78  9.74  9.75  9.76  9.76  9.76  9.75
  17 11.01 11.00 11.01 11.00 11.01 11.02 10.99 10.99 11.00 11.00 11.01 10.99
  18 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33 12.33
  19 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71 13.71
    year
age  2001  2002  2003  2004  2005  2006  2007  2008  2009  2010  2011  2012
  7   1.48  1.71  1.60  1.48  1.48  1.41  1.35  1.35  1.35  1.35  1.48  1.48
  8   1.90  2.20  2.05  1.90  1.90  1.90  1.77  1.65  1.65  1.65  1.90  1.90
  9   2.40  2.77  2.59  2.40  2.40  2.40  2.40  2.40  2.40  2.01  2.40  2.40
  10  3.00  3.47  2.82  3.00  3.00  3.00  3.00  3.00  3.00  2.45  3.00  3.00
  11  3.73  4.32  3.50  3.62  3.73  3.73  3.73  3.73  3.73  2.98  3.73  3.86
  12  4.67  5.28  4.29  4.43  4.56  4.56  4.57  4.57  4.56  3.59  4.57  4.58
  13  5.71  6.61  5.37  5.72  5.71  5.71  5.72  5.71  5.71  4.42  5.72  5.76
  14  6.51  8.16  6.63  7.06  7.05  7.05  7.06  7.05  7.05  5.39  7.06  7.65
  15  7.64  9.64  7.83  8.34  8.33  8.33  8.34  8.33  8.33  6.32  8.34  7.74
  16  9.64 11.31  9.18  9.78  9.77  9.77  9.78  9.77  9.77  7.36  9.78  9.89
  17 10.90 12.74 10.35 11.02 11.01 11.01 11.02 11.01 11.01  8.26 11.02 10.30
  18 12.33 11.95 11.58 12.33 12.32 12.32 12.33 12.32 10.76  9.21 12.33 12.41
  19 13.71 13.29 12.87 13.71 13.70 13.70 13.70 13.70 11.95 10.21 13.71 13.75
    year
age  2013
  7   1.48
  8   1.90
  9   2.40
  10  3.00
```

```
  11  4.00
  12  4.60
  13  5.80
  14  7.00
  15  8.00
  16 10.00
  17 11.00
  18 12.50
  19 13.80

units:  NA

Slot "m":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age  1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
  7  0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  8  0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  9  0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  10 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  11 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  12 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  13 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  14 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  16 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  17 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  18 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  19 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
    year
age  2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
  7  0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  8  0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  9  0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  10 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  11 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  12 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  13 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  14 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  16 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  17 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  18 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15
  19 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15

units:  NA
```

```
Slot "mat":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age  1989  1990  1991  1992  1993  1994  1995  1996  1997  1998  1999  2000
  7  0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500
  8  0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500
  9  0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625
  10 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625
  11 0.725 0.725 0.725 0.725 0.725 0.725 0.725 0.725 0.725 0.725 0.725 0.725
  12 0.775 0.775 0.775 0.775 0.775 0.775 0.775 0.775 0.775 0.775 0.775 0.775
  13 0.875 0.875 0.875 0.875 0.875 0.875 0.875 0.875 0.875 0.875 0.875 0.875
  14 0.975 0.975 0.975 0.975 0.975 0.975 0.975 0.975 0.975 0.975 0.975 0.975
  15 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
  16 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
  17 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
  18 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
  19 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
    year
age  2001  2002  2003  2004  2005  2006  2007  2008  2009  2010  2011  2012
  7  0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500
  8  0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500 0.500
  9  0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625
  10 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625
  11 0.725 0.725 0.725 0.725 0.725 0.725 0.725 0.725 0.725 0.725 0.725 0.725
  12 0.775 0.775 0.775 0.775 0.775 0.775 0.775 0.775 0.775 0.775 0.775 0.775
  13 0.875 0.875 0.875 0.875 0.875 0.875 0.875 0.875 0.875 0.875 0.875 0.875
  14 0.975 0.975 0.975 0.975 0.975 0.975 0.975 0.975 0.975 0.975 0.975 0.975
  15 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
  16 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
  17 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
  18 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
  19 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
    year
age  2013
  7  0.500
  8  0.500
  9  0.625
  10 0.625
  11 0.725
  12 0.775
  13 0.875
  14 0.975
  15 1.000
  16 1.000
  17 1.000
  18 1.000
  19 1.000
```

```
units:  NA

Slot "harvest":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age  1989       1990       1991       1992       1993       1994
  7  7.0246e-03 3.2845e-03 3.8765e-03 4.3211e-03 2.4763e-03 6.0086e-03
  8  3.0856e-02 1.5391e-02 1.7343e-02 1.8993e-02 1.2005e-02 2.0254e-02
  9  3.7908e-02 1.7945e-02 2.1430e-02 2.2417e-02 1.3927e-02 2.5843e-02
  10 1.1437e-01 5.6060e-02 6.3511e-02 7.0727e-02 4.1550e-02 7.6547e-02
  11 1.7594e-01 8.9658e-02 1.0345e-01 1.0945e-01 6.8212e-02 1.1852e-01
  12 1.8896e-01 9.2401e-02 1.0887e-01 1.1851e-01 6.9236e-02 1.2675e-01
  13 2.9807e-01 1.5802e-01 1.7613e-01 1.9813e-01 1.1692e-01 2.0454e-01
  14 3.1223e-01 1.7154e-01 1.9890e-01 2.1707e-01 1.2678e-01 2.1541e-01
  15 4.4561e-01 2.3466e-01 2.7187e-01 3.1867e-01 1.7387e-01 3.1458e-01
  16 8.3198e-01 4.7054e-01 5.2421e-01 6.1015e-01 3.6290e-01 6.3074e-01
  17 8.5793e-01 4.8894e-01 5.6042e-01 6.1223e-01 3.8056e-01 6.6058e-01
  18 5.5245e-01 3.0599e-01 3.4785e-01 3.9314e-01 2.3300e-01 4.0717e-01
  19 5.5245e-01 3.0599e-01 3.4785e-01 3.9314e-01 2.3300e-01 4.0717e-01
   year
age  1995       1996       1997       1998       1999       2000
  7  4.9960e-03 5.7363e-03 6.3894e-03 9.7755e-03 1.5175e-02 9.3360e-03
  8  1.9823e-02 2.6806e-02 2.3325e-02 2.9926e-02 5.4615e-02 1.2437e-01
  9  1.7569e-02 2.7981e-02 2.8950e-02 2.8904e-02 4.3940e-02 1.1894e-01
  10 5.7026e-02 6.2715e-02 7.6946e-02 9.2210e-02 1.0884e-01 2.5278e-01
  11 8.8256e-02 1.0638e-01 8.8531e-02 1.2824e-01 1.8696e-01 3.3812e-01
  12 9.2469e-02 1.0973e-01 1.0058e-01 9.4628e-02 1.6976e-01 4.1156e-01
  13 1.5743e-01 1.7703e-01 1.6064e-01 1.6939e-01 1.8842e-01 6.1920e-01
  14 1.9008e-01 2.1546e-01 1.7913e-01 1.8149e-01 2.2759e-01 4.4369e-01
  15 2.5775e-01 2.9569e-01 2.6189e-01 2.4664e-01 3.0650e-01 7.4227e-01
  16 4.7541e-01 5.5332e-01 4.9774e-01 5.1152e-01 5.9203e-01 1.7435e+00
  17 5.0317e-01 5.7514e-01 5.1880e-01 5.2176e-01 6.8127e-01 1.8944e+00
  18 3.1810e-01 3.6500e-01 3.2502e-01 3.2756e-01 4.0112e-01 1.0981e+00
  19 3.1810e-01 3.6500e-01 3.2502e-01 3.2756e-01 4.0112e-01 1.0981e+00
   year
age  2001       2002       2003       2004       2005       2006
  7  8.5134e-03 7.5733e-03 1.9396e-04 1.4721e-02 1.6972e-02 1.3044e-04
  8  1.4184e-02 5.7059e-02 1.3183e-04 4.8958e-02 7.8472e-02 4.7650e-02
  9  5.3413e-02 5.8026e-02 1.6972e-04 3.4281e-02 2.8732e-02 7.8644e-02
  10 1.3178e-01 3.9302e-01 1.6093e-03 9.1126e-03 1.8419e-04 1.7529e-01
  11 1.5180e-01 4.7941e-01 1.7790e-02 7.7971e-05 2.3124e-04 5.4236e-01
  12 1.5291e-01 4.1027e-01 1.6847e-01 3.8627e-04 9.0597e-05 5.0116e-01
  13 3.1099e-01 3.5950e-01 3.4276e-01 5.5050e-03 4.7336e-02 1.3733e-01
  14 5.6447e-01 3.7204e-01 3.7012e-01 3.4549e-02 2.5009e-01 1.4572e-01
  15 3.2672e-01 1.8759e-01 7.8861e-01 1.4504e-01 6.5546e-01 7.9772e-04
  16 6.5070e-01 2.9392e-02 3.7828e-01 9.1471e-01 6.4469e-01 3.2685e-01
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```
  17 5.0697e+00 1.5903e-02 2.0275e-01 1.7739e+00 3.9055e+00 3.6553e-01
  18 1.3979e+00 1.9355e-01 4.1876e-01 5.7864e-01 1.1134e+00 1.9858e-01
  19 1.3979e+00 1.9355e-01 4.1876e-01 5.7864e-01 1.1134e+00 1.9858e-01
    year
age  2007       2008       2009       2010       2011       2012
  7  2.4582e-04 1.7059e-04 1.5295e-04 1.4422e-03 1.8203e-03 7.0811e-04
  8  1.5157e-04 2.8568e-04 1.9823e-04 6.9549e-03 7.8558e-03 3.3926e-03
  9  1.7324e-02 1.7613e-04 9.0262e-02 9.9538e-03 9.6100e-03 3.7158e-03
  10 5.7590e-02 2.7817e-04 3.3272e-01 5.1092e-02 3.4650e-02 1.1776e-02
  11 6.8770e-02 4.7185e-04 3.9329e-01 5.5571e-02 9.3531e-02 2.1690e-02
  12 1.3341e-01 5.5920e-02 3.9005e-01 8.2924e-02 6.3911e-02 4.1681e-02
  13 3.5800e-01 1.8130e-01 4.9281e-01 2.0157e-01 1.5631e-01 4.6993e-02
  14 7.4394e-02 1.8169e-01 5.3650e-01 2.3131e-01 2.4933e-01 3.0696e-01
  15 2.4156e-01 5.2635e-02 4.2288e-01 3.0649e-01 4.2610e-01 6.5880e-01
  16 6.4206e-01 1.0017e+00 4.4185e-02 6.4243e-01 8.9237e-01 8.1786e-01
  17 5.2451e-01 4.6912e+00 3.8545e-01 3.4266e-02 1.0356e+00 5.1239e-01
  18 3.7193e-01 1.2371e+00 3.0005e-01 3.3950e-01 1.6461e-02 3.6515e-01
  19 3.7193e-01 1.2371e+00 3.0005e-01 3.3950e-01 1.6461e-02 3.6515e-01
    year
age  2013
  7  1.6244e-04
  8  2.0577e-04
  9  2.4680e-04
  10 2.5445e-04
  11 1.5313e-02
  12 4.2179e-02
  13 1.3652e-01
  14 1.4094e-01
  15 5.1476e-01
  16 6.5204e-01
  17 6.5601e-01
  18 1.2838e+00
  19 1.2838e+00

units:  f

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  8  0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
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```
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 19 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   year
age  2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
  7 0   0    0    0    0    0    0    0    0    0
  8 0   0    0    0    0    0    0    0    0    0
  9 0   0    0    0    0    0    0    0    0    0
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units:  NA

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   year
age  1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
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   year
age  2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
  7 0   0    0    0    0    0    0    0    0    0
  8 0   0    0    0    0    0    0    0    0    0
  9 0   0    0    0    0    0    0    0    0    0
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"

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       7        19        19      1989      2013        10        17
```

6.6.4.4 Results

The VIT software was applied to assess population parameters based on pseudocohort analyses for the 1989-2013 data. In the analyses three groups of years have been used: 1989, 1990, 1991; 2001, 2002, 2003 and 2010, 2011, 2012 and 2013. For these years two scenarios were investigated using Fterminal = 0.5 and Fterminal = 0.15. The two scenarios were run with M=0.15, and, M = 0.2.

For $F_{terminal}$ = 0.5, the results are the following:

Table 6.6.4.4.1 – Total F obtained using $F_{terminal}$ =0.5

Year	Total F	Bg	Ge	Ro	Ru	Tk	Uk
1989	0.277	0	0.001	0	0	0.259	0.018
1990	0.277	0	0.002	0	0.003	0.106	0.167
1991	0.277	0	0	0	0	0.241	0.036
2001	0.282	0.008	0.001	0	0.001	0.258	0.014
2002	0.347	0.028	0.012	0	0.001	0.279	0.026
2003	0.370	0.014	0.009	0	0.005	0.183	0.16
2010	0.278	0.173	0	0.001	0.007	0.025	0.072
2011	0.277	0.129	0	0.001	0.001	0.063	0.083
2012	0.344	0.117	0.001	0.001	0.005	0.195	0.025
2013	0.231	0.119	0	0.009	0.002	0.078	0.022

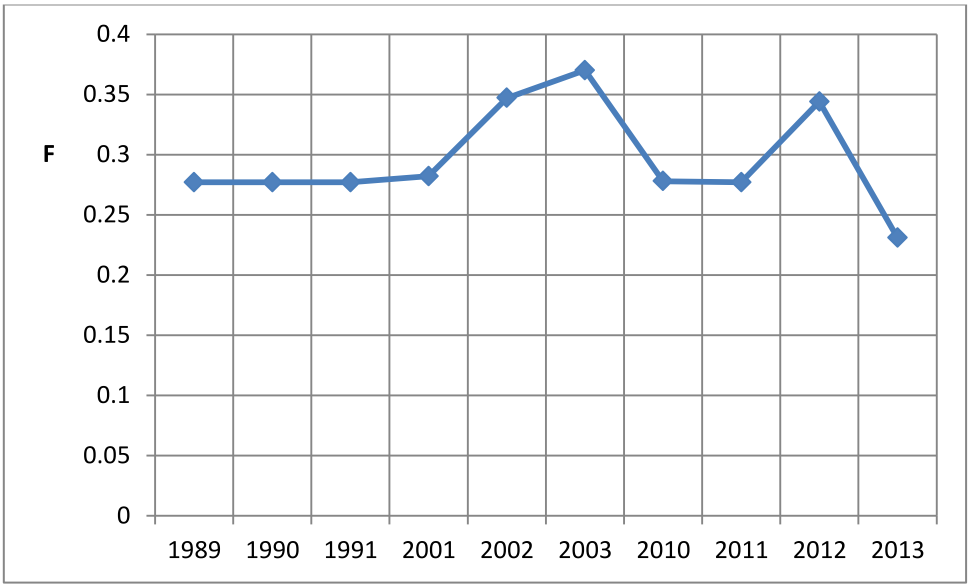


Fig. 6.6.4.4.1 Total F in the case of using the Fterminal = 0.5

Table 6.6.4.4.2 - The biomasses obtained using Fterminal =0.5

	1989	**1990**	**1991**	**2001**	**2002**	**2003**	**2010**	**2011**	**2012**	**2013**
Mean biomass (kg)	6304800095.48	1857414441.97	2786875948.00	712688989.40	383858170.00	151897288.60	50473168.00	52200571.00	42477497	17257926.6
SSB (kg)	6304800095.48	1857414441.97	2786875948.00	712688989.40	322328546.70	151897288.60	50473168.00	52200571.00	42477497	17257926.6
Recruitment biomass (kg)	953922314.34	281026915.60	421657303.50	107805121.30	32524541.38	33812017.94	7637430.00	7898374.00	6296022	4337220.71
Growth biomass (kg)	550529775.96	162192667.19	243350126.30	62355718.60	56642985.09	8674145.15	4407944.00	4558087.00	3750589	756331.77
Natural death biomas (kg)	945720014.32	278612166.30	418031392.20	106903348.40	51844261.05	22784593.29	7570975.00	7830086.00	6371625	2588688.97

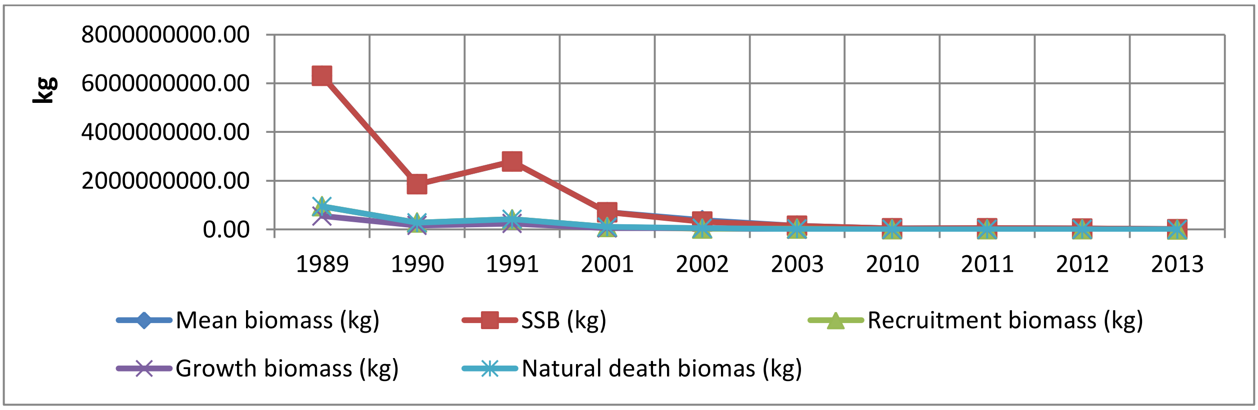


Fig. 6.6.4.4.2 The biomasses obtained using Fterminal = 0.5

Table 6.6.4.4.3 Total F obtained using Fterminal = 0.15

	Total F	Bg	Ge	Ro	Ru	Tk	Ukr
2001	0.180	0.007	0	0	0	0.164	0.009
2002	0.249	0.02	0.008	0	0.001	0.201	0.019
2003	0.238	0.009	0.006	0	0.003	0.118	0.103
2010	0.177	0.11	0	0.001	0.005	0.016	0.046
2011	0.176	0.082	0	0.001	0.001	0.04	0.053
2012	0.239	0.103	0	0.001	0.003	0.117	0.015
2013	0.112	0.058	0	0.005	0.001	0.038	0.011

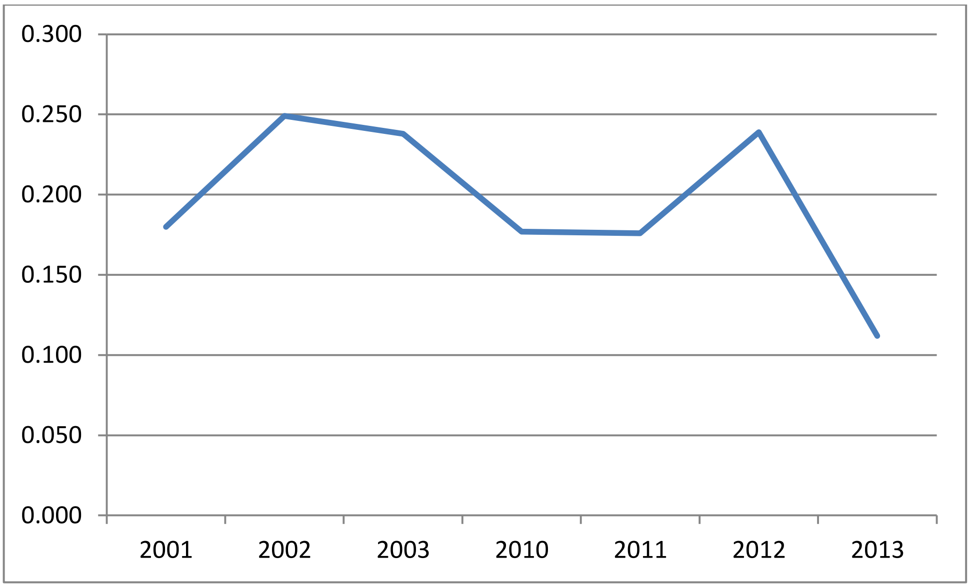


Fig. 6.6.4.4.3 Total F in the case of using the Fterminal = 0.15

Table- 6.6.4.4.4 The biomasses obtained using Fterminal =0.15

	2001	2002	2003	2010	2011	2012	2013
Mean biomass (kg)	789668568	397286126.1	168847423.2	56201852	58172429	44522958	27278589
SSB (kg)	789668568	397286126.1	168847423.2	56201852	58172429	44522958	27278589
Recruitment biomass (kg)	116340957	33323505.33	36393208.91	8272674	8560596	6522407	5998871
Growth biomass (kg)	65391347.1	57731304.41	8643811.89	4633754	4793457	3832396	608806
Natural death biomas (kg)	118450285	53717561.99	25327113.48	8430278	8725864	6678444	4091788

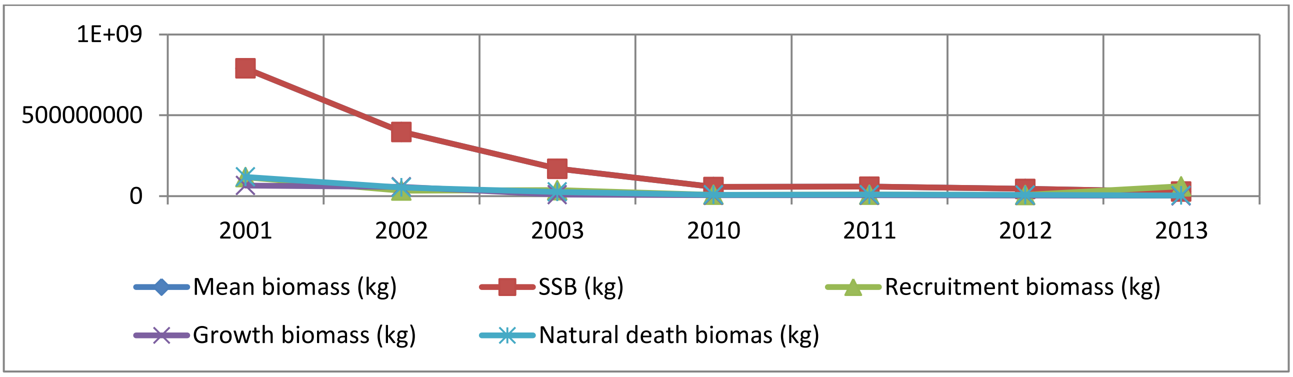


Fig. 6.6.4.4.4 The biomasses obtained using Fterminal = 0.15

Comparing the obtained results in a period of 25 years the stock biomass has decreased dramatically. Only in the last 15 years the biomass decreased about 20 times.

Table 6.6.4.4.5 Results for 2013 data using Fterminal =0.5

---	**Total**	**Bg**	**Ge**	**Ro**	**Ru**	**Tr**	**Uk**	
Catch mean age	15.017	15.018	15.032	15.019	15.022	15.016	15.017	
Catch mean length	136.959	136.96	136.983	136.962	136.966	136.957	136.958	
Mean F	0.231	0.119	0	0.009	0.002	0.078	0.022	
Global F	0.135	0.07	0	0.005	0.001	0.045	0.013	
Total catch	2504863.5	1296196	3054.71	101929	21687.2	844732	237265	
Catch/D%	49.18	25.45	0.06	2	0.43	16.68	4.66	
Catch/B%	14.51	7.51	0.02	0.59	0.13	4.89	1.37	
B/R	SSB/R	Y/R	Y/R Bg	Y/R Ge	Y/R Ro	Y/R Ru	Y/R Tr	Y/R Uk
27701.191	27701.191	4020.628	2080.56	4.903	163.61	34.811	1355.9	380.841
Current Stock Mean Age	13.49							
Current Stock Critical Age	11							
Virgin Stock Critical Age	11							
Current Stock Mean Length	132.679							
Current Stock Critical Length	124.462							
Virgin Stock Critical Length	124.462							
Number of recruits, R	623							
Mean Biomass, Bmean	17257926							
Spawning Stock	1725792							

Biomass, SSB	6							
Biomass Balance, D	5093552.5							
Natural death/D	50.82							
Bmax/Bmean	25.13							
Turnover, D/Bmean	29.51							
Class	Lower Age	Mean Age	Lower Length	Mean Length	Lower Weight	Mean Weight	Maturity ratio	
1	11	11.485	124.462	126.426	6961.8	7230.94	1	
2	12	12.482	128.417	130.125	7507.82	7751.83	1	
3	13	13.478	131.877	133.356	8005.28	8224.41	1	
4	14	14.47	134.902	136.175	8455.75	8650.18	1	
5	15	15.454	137.548	138.623	8861.62	9030.14	1	
6	16	16.465	139.862	140.826	9225.76	9380.28	1	
7	17	17.471	141.886	142.739	9551.29	9690.79	1	
8	18	18.463	143.656	144.39	9841.43	9963.47	1	
9	19	19.446	145.204	145.823	10099.4	10203.8	1	
+	20	---	146.658	---	10328.2	---		
Catch in Numbers								
Class	Total catch	Catch of Bg	Catch of Ge	Catch of Ro	Catch of Ru	Catch of Tr	Catch of Uk	
1	14.26	7.39	0.02	0.58	0.12	4.8	1.35	
2	28.49	14.74	0.03	1.16	0.24	9.62	2.7	
3	42.75	22.12	0.05	1.74	0.37	14.42	4.05	
4	56.97	29.47	0.07	2.32	0.49	19.22	5.4	
5	71.25	36.86	0.09	2.89	0.61	24.04	6.75	
6	28.49	14.74	0.03	1.16	0.24	9.62	2.7	
7	14.26	7.39	0.02	0.58	0.12	4.8	1.35	
8	14.26	7.39	0.02	0.58	0.12	4.8	1.35	
9	14.26	7.39	0.02	0.58	0.12	4.8	1.35	
Total	285	147.48	0.35	11.6	2.47	96.12	27	
Mean Age	15.017	15.018	15.032	15.019	15.022	15.016	15.017	
Mean Length	136.959	136.96	136.983	136.962	136.966	136.957	136.958	
Catch in Weight								
Class	Total catch	Catch of Bg	Catch of Ge	Catch of Ro	Catch of Ru	Catch of Tr	Catch of Uk	
1	103107.65	53414.06	130.16	4215.35	902.42	34685.4	9760.32	
2	220883.2	114235.9	265.11	8957.32	1897.65	74600.4	20926.8	
3	351622.83	181952.9	429.31	14297.9	3039.74	118599	33303.9	
4	492834.5	254949.	591.67	20080.8	4276.65	166232	46704	

	7	3					.1	
5	643378.14	332852.2	780.2	26133	5548.11	217120	60944.4	
6	267284.73	138233.8	320.81	10839	2296.29	90271.9	25323	
7	138183.23	71584.66	174.43	5649.34	1209.41	46484.8	13080.6	
8	142071.49	73598.95	179.34	5808.3	1243.44	47792.8	13448.7	
9	145497.68	75373.86	183.67	5948.38	1273.43	48945.3	13773	
Total	2504863.5	1296196	3054.71	101929	21687.2	844732	237265	
Percentage	---	51.75	0.12	4.07	0.87	33.72	9.47	
VPA Results--Numbers								
Class	Initial number	Mean number						
1	623	571.55						
2	523.01	471.65						
3	423.77	372.3						
4	325.17	273.27						
5	227.21	174.02						
6	129.86	106.11						
7	85.45	72.18						
8	60.36	48.78						
9	38.78	28.52						
Total	---	2118.37						
Stock Mean Age	---	13.49						
Stock Mean Length	---	132.679						
VPA Results--Weight								
Class	Initial Weight	Mean Weight						
1	4337220.7	4132842						
2	3926676.1	3656161						
3	3392392	3061920						
4	2749566.8	2363824						
5	2013421.8	1571396						
6	1198024.9	995312.2						
7	816121.19	699462.4						
8	594031.03	486012.4						
9	391694.5	290995.						

	1	4						
Total	---	17257926						
SSB	---	17257926						
VPA Results--Mortalities								
Class	Z	Total F	F of Bg	F of Ge	F of Ro	F of Ru	F of Tr	F of Uk
1	0.175	0.025	0.013	0	0.001	0	0.008	0.002
2	0.21	0.06	0.031	0	0.002	0.001	0.02	0.006
3	0.265	0.115	0.059	0	0.005	0.001	0.039	0.011
4	0.358	0.208	0.108	0	0.008	0.002	0.07	0.02
5	0.559	0.409	0.212	0	0.017	0.004	0.138	0.039
6	0.419	0.269	0.139	0	0.011	0.002	0.091	0.025
7	0.348	0.198	0.102	0	0.008	0.002	0.066	0.019
8	0.442	0.292	0.151	0	0.012	0.003	0.098	0.028
9	0.65	0.5	0.259	0.001	0.02	0.004	0.168	0.047
Mean Mort. rates	0.381	0.231	0.119	0	0.009	0.002	0.078	0.022
Global Fs	---	0.135	0.07	0	0.005	0.001	0.045	0.013
---	Critical age	Critical length						
Current stock	11	124.462						
Virgin stock	11	124.462						
Total Biomass balance (D): 5093552.48								
---	Biomass	Percentage						
Recruitment	4337220.7	85.15						
Growth	756331.77	14.85						
Natural death	2588689	50.82						
Fishing	2504863.5	49.18						
R/B(mean)	25.13							
D/B(mean)	29.51							
B(max)/B(mean)	25.13							
B(max)/D	85.15							

Table 6.6.4.4.6 Results for 2013 data using Fterminal =0.15---	**Total**	**Bg**	**Ge**	**Ro**	**Ru**	**Tr**	**Uk**	
Catch mean age	15.026	15.027	15.041	15.028	15.031	15.025	15.026	
Catch mean length	136.978	136.97	137.003	136.981	136.985	136.976	136.9	

		9					78	
Mean F	0.112	0.058	0	0.005	0.001	0.038	0.011	
Global F	0.087	0.045	0	0.004	0.001	0.029	0.008	
Total catch	2505730	129664 4	3055.77	101965	21694.7	845024	23734 7	
Catch/D%	37.98	19.65	0.05	1.55	0.33	12.81	3.6	
Catch/B%	9.19	4.75	0.01	0.37	0.08	3.1	0.87	
B/R	SSB/R	Y/R	Y/R Bg	Ge	Y/R Ro	Y/R Ru	Y/R Tr	Y/R Uk
31710.989	31710.99	2912.8 77	1507.33	3.552	118.533	25.22	982.3 29	275.9 13
Current Stock Mean Age	13.856							
Current Stock Critical Age	11							
Virgin Stock Critical Age	11							
Current Stock Mean Length	133.6							
Current Stock Critical Length	124.462							
Virgin Stock Critical Length	124.462							
Number of recruits, R	860.23							
Mean Biomass, Bmean	2727858 9							
Spawning Stock Biomass, SSB	2727858 9							
Biomass Balance, D	6597518							
Natural death/D	62.02							
Bmax/Bmean	21.95							
Turnover, D/Bmean	24.19							
Class	Lower Age	Mean Age	Lower Length	Mean Length	Lower Weight	Mean Weight	Maturity ratio	
1	11	11.486	124.462	126.429	6961.8	7231.25	1	
2	12	12.484	128.417	130.13	7507.82	7752.55	1	
3	13	13.481	131.877	133.365	8005.28	8225.72	1	
4	14	14.476	134.902	136.191	8455.75	8652.57	1	
5	15	15.468	137.548	138.655	8861.62	9035.2	1	
6	16	16.476	139.862	140.848	9225.76	9383.87	1	
7	17	17.48	141.886	142.755	9551.29	9693.42	1	
8	18	18.478	143.656	144.413	9841.43	9967.3	1	
9	19	19.475	145.204	145.862	10099.4	10210.4	1	
+	20	---	146.658	---	10328.2	---		

Catch in Numbers								
Class	Total catch	Catch of Bg	Catch of Ge	Catch of Ro	Catch of Ru	Catch of Tr	Catch of Uk	
1	14.26	7.39	0.02	0.58	0.12	4.8	1.35	
2	28.49	14.74	0.03	1.16	0.24	9.62	2.7	
3	42.75	22.12	0.05	1.74	0.37	14.42	4.05	
4	56.97	29.47	0.07	2.32	0.49	19.22	5.4	
5	71.25	36.86	0.09	2.89	0.61	24.04	6.75	
6	28.49	14.74	0.03	1.16	0.24	9.62	2.7	
7	14.26	7.39	0.02	0.58	0.12	4.8	1.35	
8	14.26	7.39	0.02	0.58	0.12	4.8	1.35	
9	14.26	7.39	0.02	0.58	0.12	4.8	1.35	
Total	285	147.48	0.35	11.6	2.47	96.12	27	
Mean Age	15.026	15.027	15.041	15.028	15.031	15.025	15.026	
Mean Length	136.978	136.979	137.003	136.981	136.985	136.976	136.978	
Catch in Weight								
Class	Total catch	Catch ofBg	Catch of Ge	Catch of Ro	Catch of Ru	Catch of Tr	Catch of Uk	
1	103112.2	53416.39	130.16	4215.53	902.46	34686.9	9760.74	
2	220903.6	114246.6	265.14	8958.15	1897.82	74607.3	20928.8	
3	351678.9	181981.9	429.38	14300.2	3040.23	118618	33309.2	
4	492970.6	255019.6	591.84	20086.3	4277.83	166278	46717	
5	643739	333038.9	780.64	26147.7	5551.23	217242	60978.6	
6	267387	138286.7	320.93	10843.2	2297.17	90306.4	25332.7	
7	138220.8	71604.13	174.48	5650.88	1209.74	46497.4	13084.2	
8	142126.1	73627.23	179.41	5810.54	1243.92	47811.1	13453.9	
9	145591.9	75422.66	183.79	5952.23	1274.25	48977	13781.9	
Total	2505730	1296644	3055.77	101965	21694.7	845024	237347	
Percentage	---	51.75	0.12	4.07	0.87	33.72	9.47	
VPA Results--Numbers								
Class	Initial number	Mean number						
1	860.23	791.85						
2	727.19	661.29						
3	599.5	535.6						
4	476.41	414.02						
5	357.33	295.77						

6	241.72	210.27						
7	181.68	161.66						
8	143.17	125.88						
9	110.03	95.06						
Total	---	3291.4						
Stock Mean Age	---	13.856						
Stock Mean Length	---	133.6						
VPA Results--Weight								
Class	Initial Weight	Mean Weight						
1	5988713	5726033						
2	5459607	5126695						
3	4799174	4405686						
4	4028384	3582330						
5	3166530	2672321						
6	2230029	1973180						
7	1735301	1567079						
8	1409032	1254652						
9	1111261	970612.6						
Total	---	27278589						
SSB	---	27278589						
VPA Results--Mortalities								
Class	Z	Total F	F of Bg	F of Ge	F of Ro	F of Ru	F of Tr	F of Uk
1	0.168	0.018	0.009	0	0.001	0	0.006	0.002
2	0.193	0.043	0.022	0	0.002	0	0.015	0.004
3	0.23	0.08	0.041	0	0.003	0.001	0.027	0.008
4	0.288	0.138	0.071	0	0.006	0.001	0.046	0.013
5	0.391	0.241	0.125	0	0.01	0.002	0.081	0.023
6	0.286	0.136	0.07	0	0.005	0.001	0.046	0.013
7	0.238	0.088	0.046	0	0.004	0.001	0.03	0.008
8	0.263	0.113	0.059	0	0.005	0.001	0.038	0.011
9	0.3	0.15	0.078	0	0.006	0.001	0.05	0.014
Mean Mort. rates	0.262	0.112	0.058	0	0.005	0.001	0.038	0.011
Global Fs	---	0.087	0.045	0	0.004	0.001	0.029	0.008
---	Critical age	Critical length						

Current stock	11	124.46 2						
Virgin stock	11	124.46 2						
Total Biomass balance (D): 6597518.45								
---	Biomass	Percentage						
Recruitment	5988713	90.77						
Growth	608805.9	9.23						
Natural death	4091788	62.02						
Fishing	2505730	37.98						
R/B(mean)	21.95							
D/B(mean)	24.19							
B(max)/B(mean)	21.95							
B(max)/D	90.77							

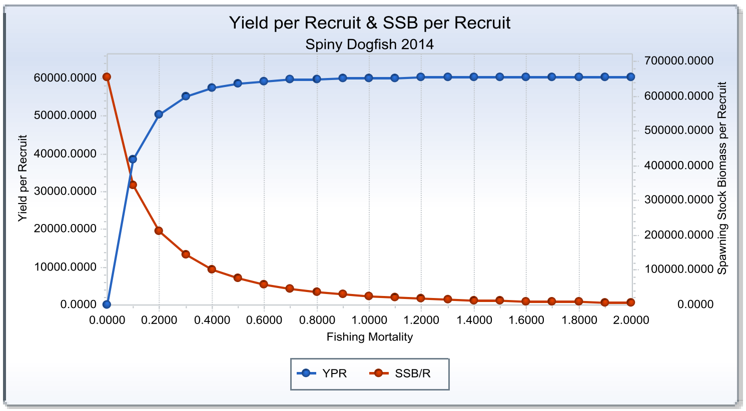
Table 6.6.4.4.7 Reference points for Black Sea Piked Dogfish 2012 using YPRLEN with M= 0.15

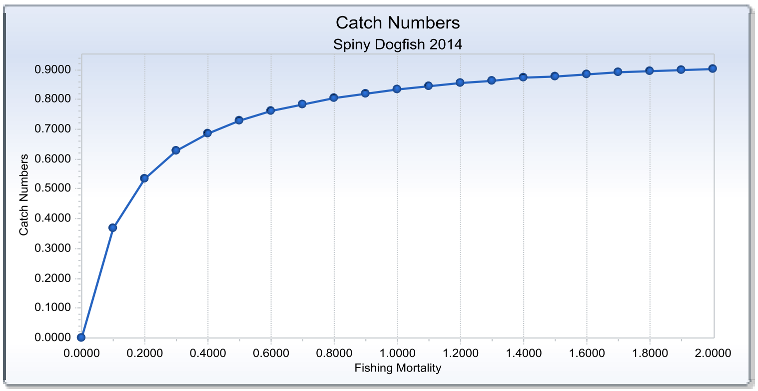
Reference Point	F	YPR	SSB/R	TSB/R
F-zero	0	0	2016927.973	2565302.335
F0.1	0.1772	141775.8723	681852.3199	1189739.304
Fmax	0.4538	158447.8695	232975.4451	689373.6313
Fat 30%MSP	0.202	146340.5887	605483.4199	1108217.316

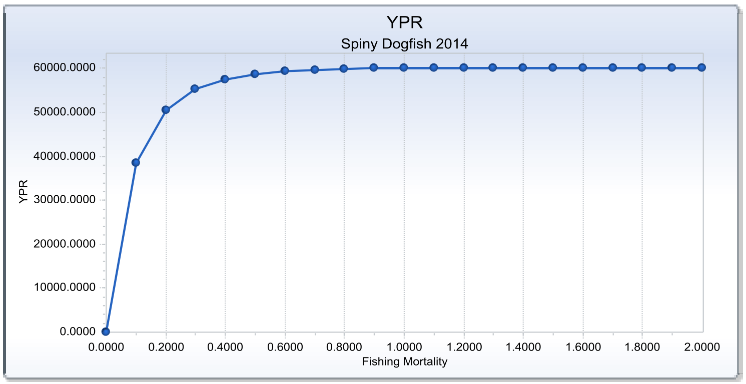
Table 6.6.4.4.8 Reference points for Black Sea Piked Dogfish 2013 using YPRLEN with M= 0.15

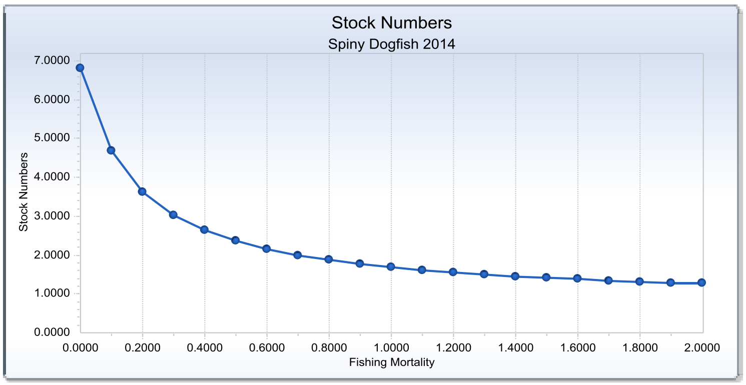
Reference Point	F	YPR	SSB/R	TSB/R
F-zero	0	0	653531.1381	782635.0081
F0.1	0.204	50785.81319	208158.9717	327176.2242
Fmax	2	60216.1516	6133.79398	83980.60937
Fat 30%MSP	0.218	51683.06615	196176.77	314570.6882

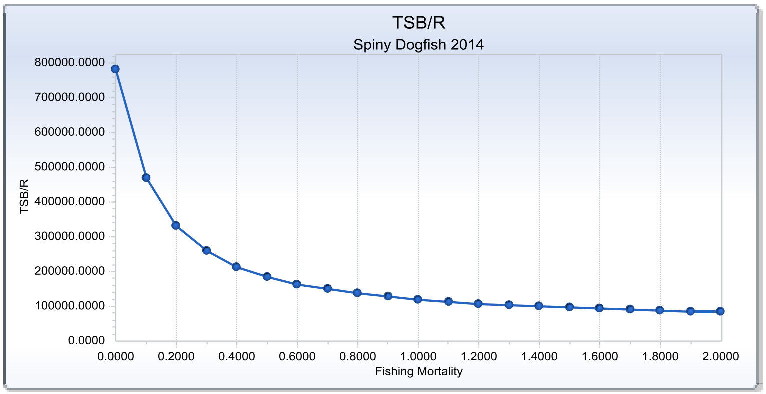
Graphs obtained using M = 0.15 constant

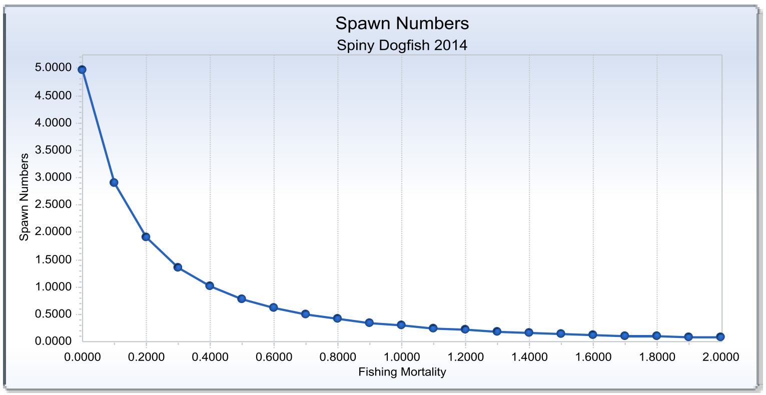


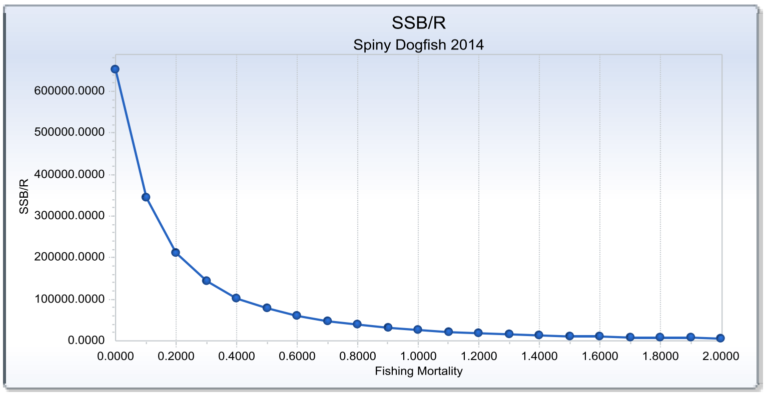

Catch Numbers
Spiny Dogfish 2014
Catch Numbers
0.9000
0.8000
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
0.0000
0.2000
0.4000
0.6000
0.8000
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality

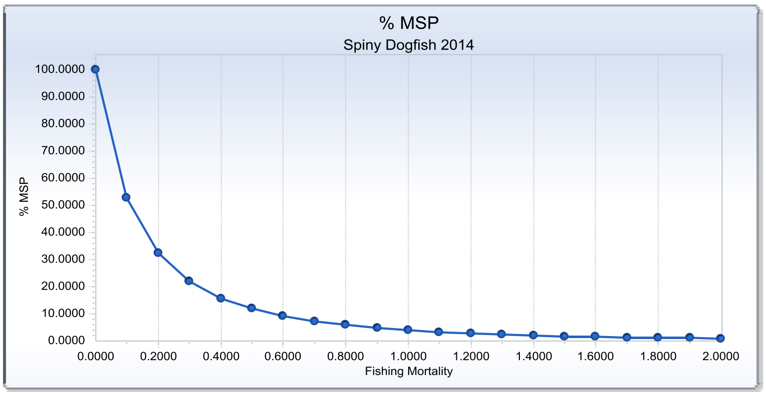

YPR
Spiny Dogfish 2014
YPR
60000.0000
50000.0000
40000.0000
30000.0000
20000.0000
10000.0000
0.0000
0.0000
0.2000
0.4000
0.6000
0.8000
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality

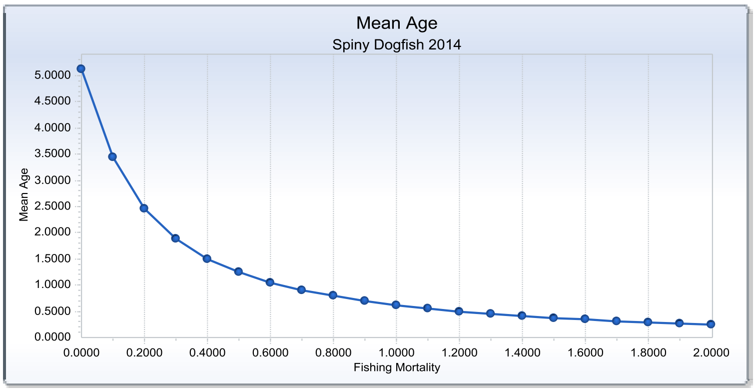

Stock Numbers
Spiny Dogfish 2014
Stock Numbers
7.0000
6.0000
5.0000
4.0000
3.0000
2.0000
1.0000
0.0000
0.0000
0.2000
0.4000
0.6000
0.8000
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality

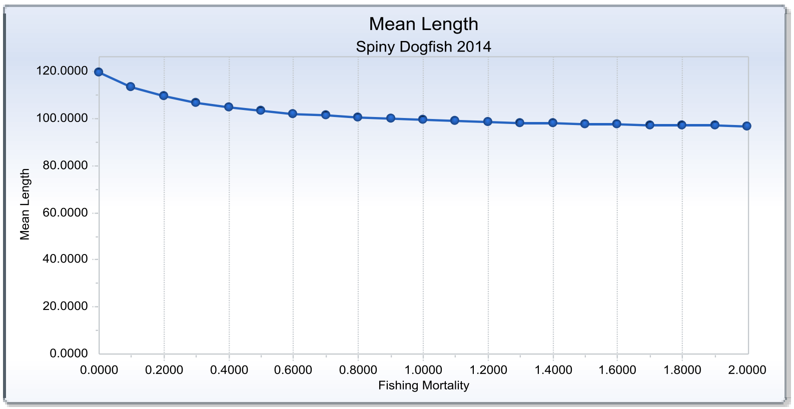

TSB/R
Spiny Dogfish 2014
TSB/R
800000.0000
700000.0000
600000.0000
500000.0000
400000.0000
300000.0000
200000.0000
100000.0000
0.0000
0.0000
0.2000
0.4000
0.6000
0.8000
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality

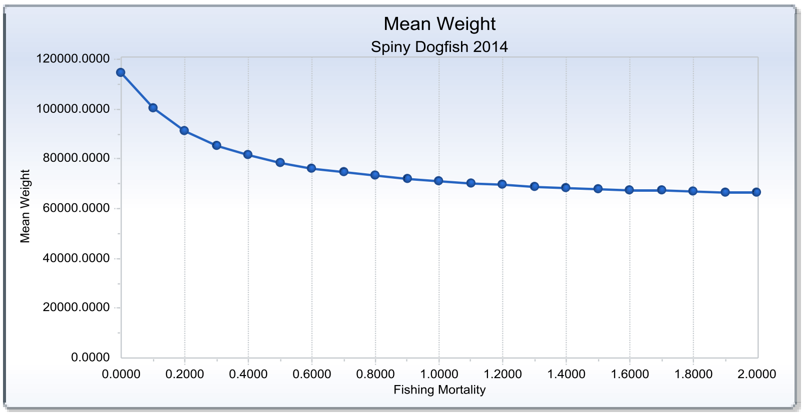

Spawn Numbers
Spiny Dogfish 2014
Spawn Numbers
5.0000
4.5000
4.0000
3.5000
3.0000
2.5000
2.0000
1.5000
1.0000
0.5000
0.0000
0.0000
0.2000
0.4000
0.6000
0.8000
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality

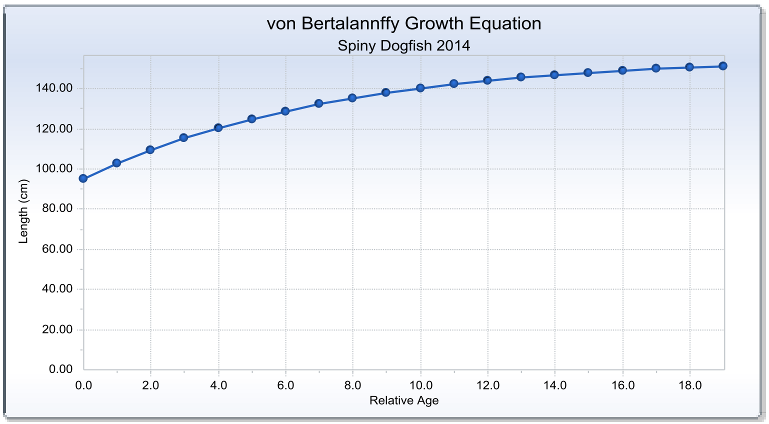

SSB/R
Spiny Dogfish 2014
SSB/R
600000.0000
500000.0000
400000.0000
300000.0000
200000.0000
100000.0000
0.0000
0.0000
0.2000
0.4000
0.6000
0.8000
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality

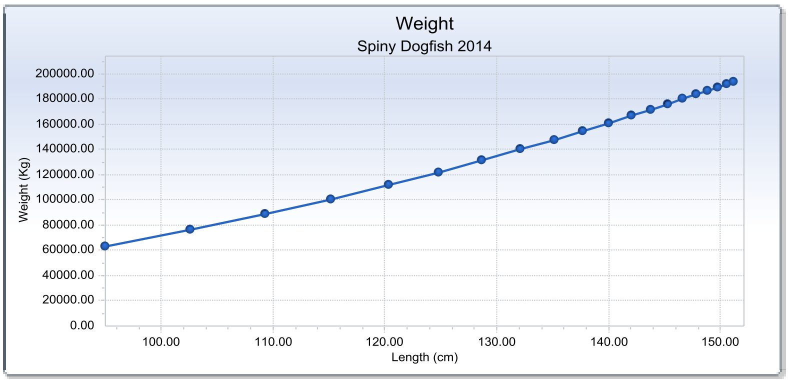

% MSP
Spiny Dogfish 2014
% MSP
100.0000
90.0000
80.0000
70.0000
60.0000
50.0000
40.0000
30.0000
20.0000
10.0000
0.0000
0.0000
0.2000
0.4000
0.6000
0.8000
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality

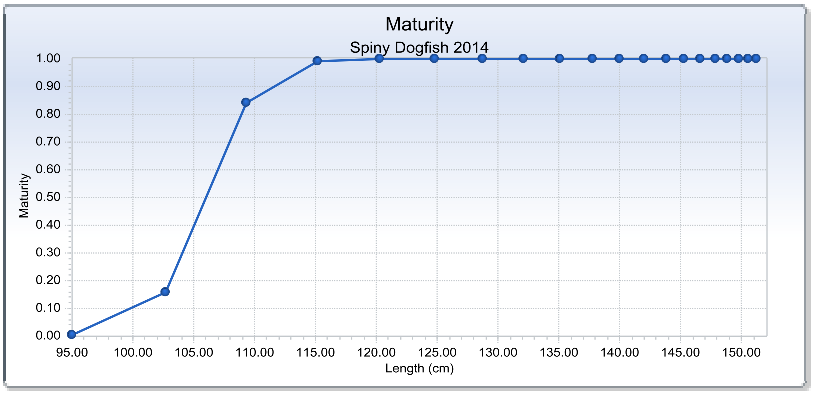

Mean Age
Spiny Dogfish 2014
Mean Age
5.0000
4.5000
4.0000
3.5000
3.0000
2.5000
2.0000
1.5000
1.0000
0.5000
0.0000
0.0000
0.2000
0.4000
0.6000
0.8000
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality

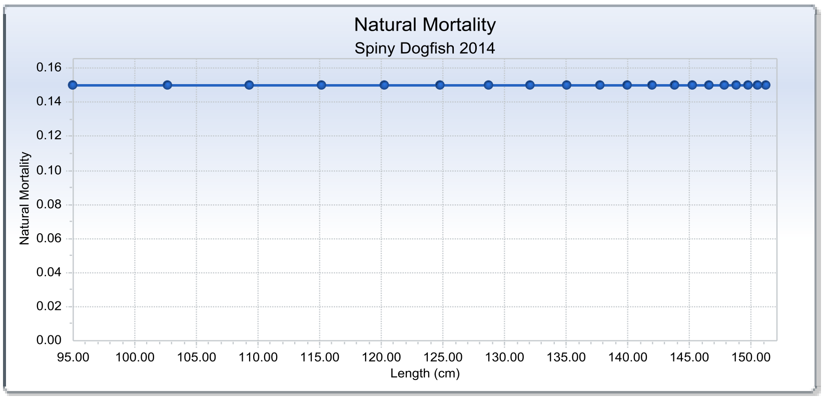

Mean Length
Spiny Dogfish 2014
Mean Length
120.0000
100.0000
80.0000
60.0000
40.0000
20.0000
0.0000
0.0000
0.2000
0.4000
0.6000
0.8000
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality

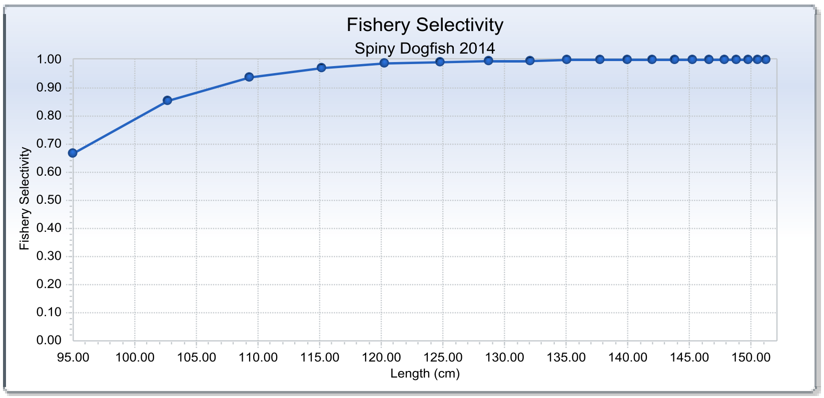

Mean Weight
Spiny Dogfish 2014
Mean Weight
120000.0000
100000.0000
80000.0000
60000.0000
40000.0000
20000.0000
0.0000
0.0000
0.2000
0.4000
0.6000
0.8000
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality


von Bertalannffy Growth Equation
Spiny Dogfish 2014
Length (cm)
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
Relative Age


Weight
Spiny Dogfish 2014
Weight (Kg)
200000.00
180000.00
160000.00
140000.00
120000.00
100000.00
80000.00
60000.00
40000.00
20000.00
0.00
100.00
110.00
120.00
130.00
140.00
150.00
Length (cm)







6.6.4.5. Results using XSA:

The XSA assessment was conducted in an exploratory fashion, with tuning provided by the Romanian scientific demersal surveys conducted during 2011 to 2013. The results indicated a steady and major reduction in the spawning stock biomass since 1989. The estimates of current rates of fishing mortality are high (~0.3) and estimates of F for past years were erratic, exceeding 0.7 four times during 1999 to 2009. Detailed outputs can be traced in figs 6.6.4.5.1-6.6.4.5.13 and Table 6.6.4.5.1.

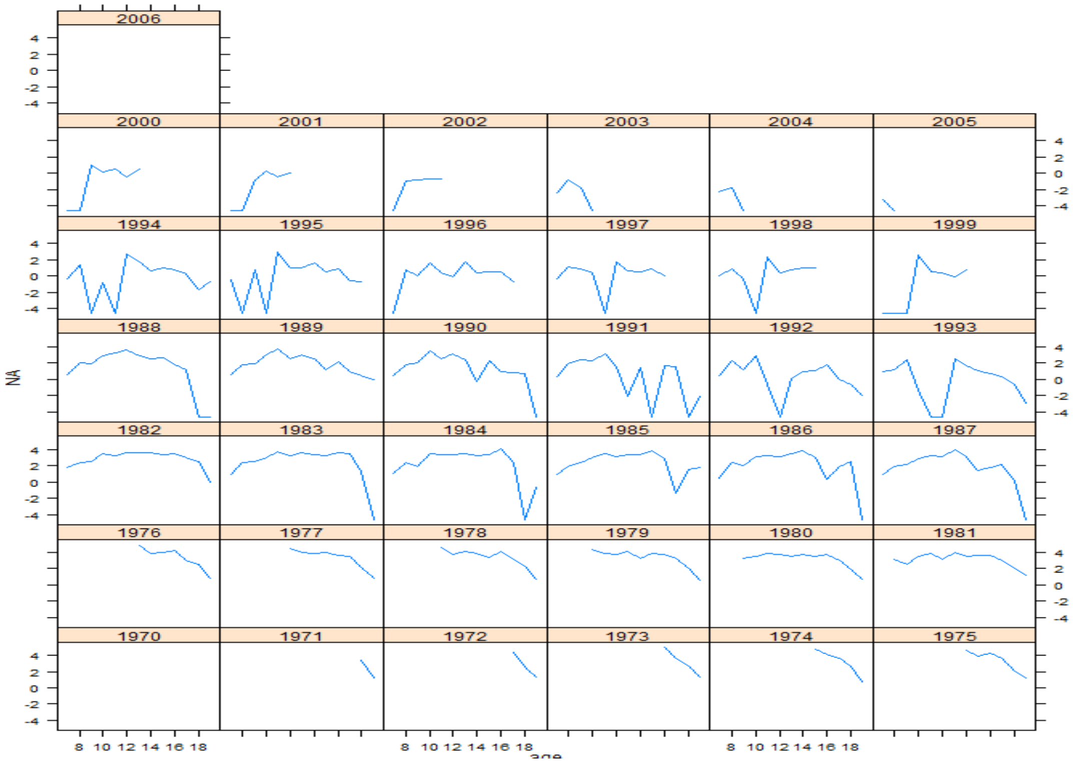


Figure 6.6.4.5.1 Coohort of Spurdog in Black Sea

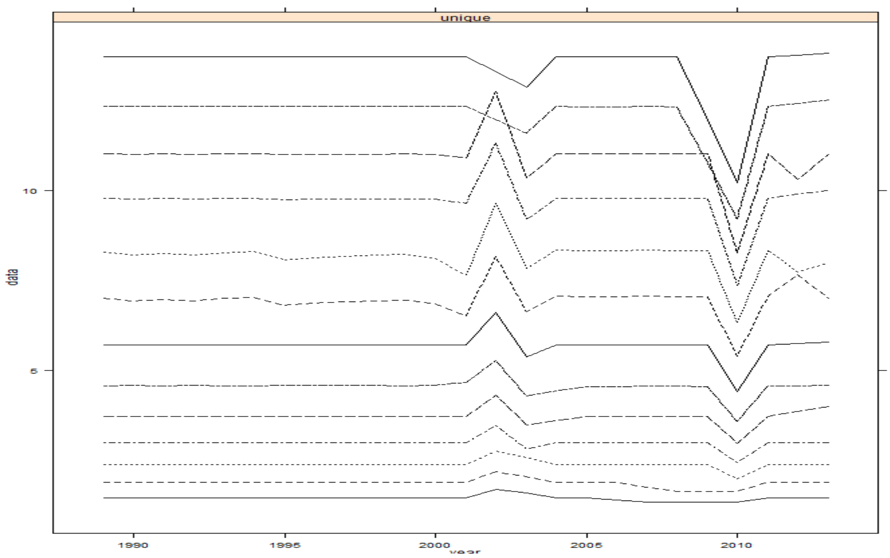


Figure 6.6.4.5.2 Weight at age by year for Spurdog in Black Sea

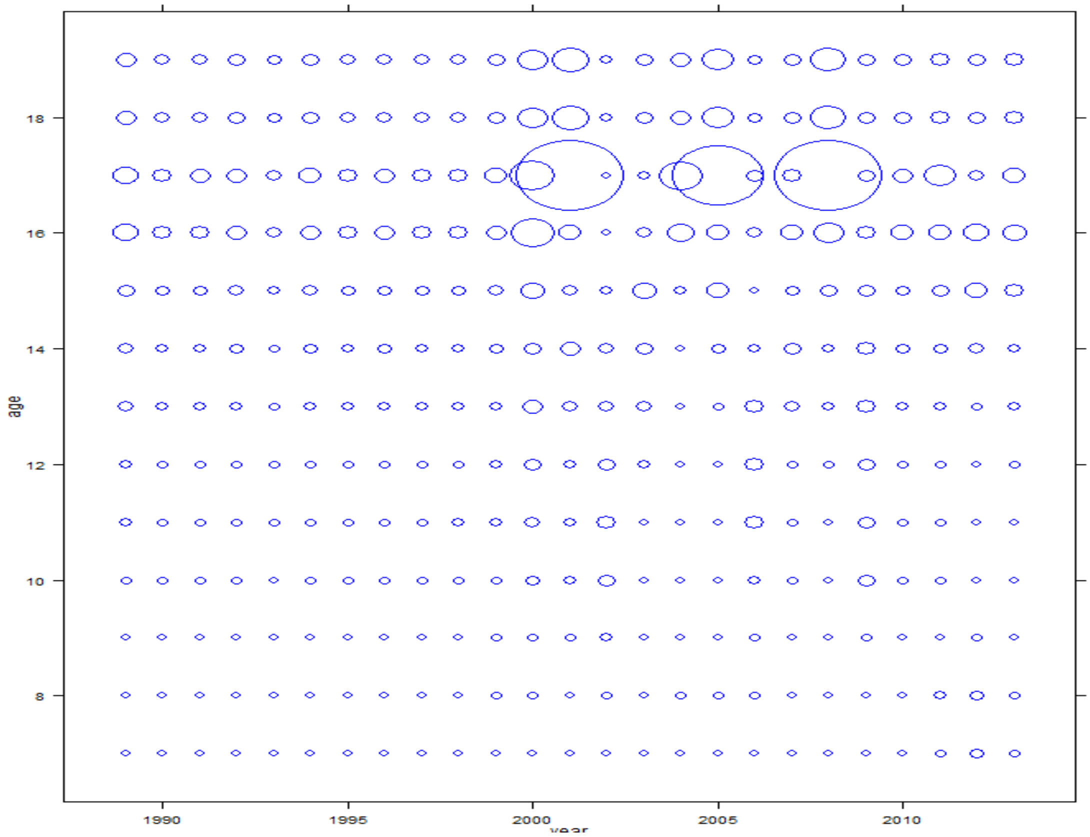


Figure 6.6.4.5.3 Catch at age matrix for Spurdog in Black Sea

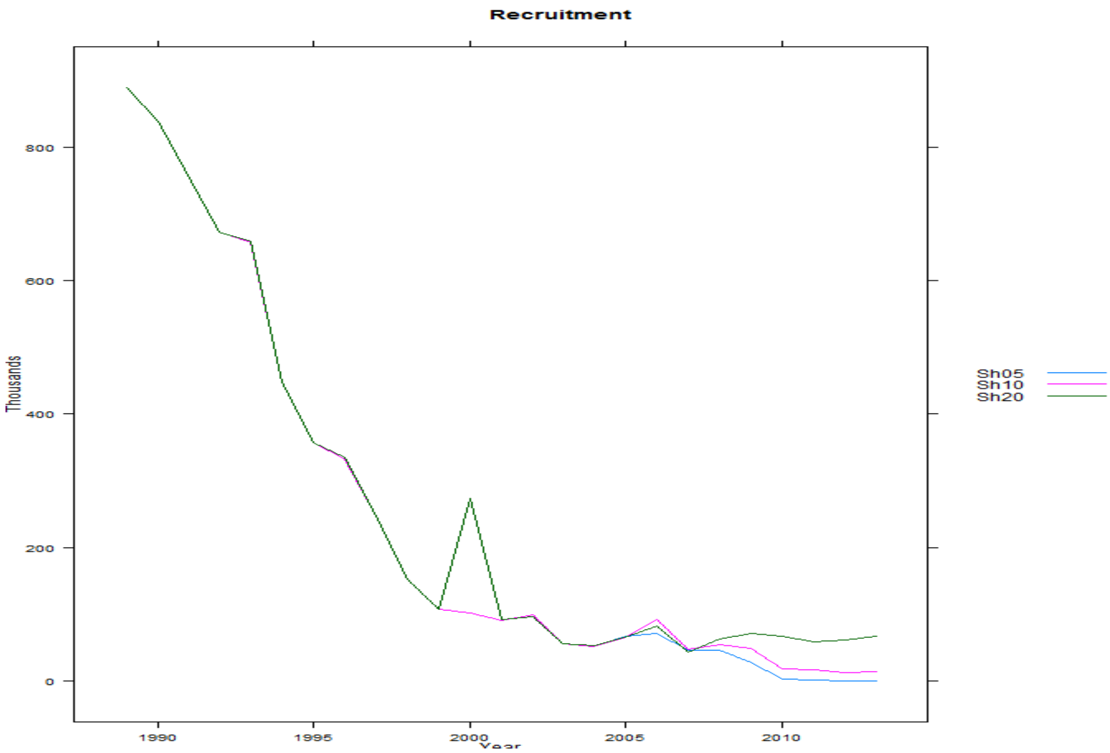


Figure 6.6.4.5.4 Recriutment estimated by XSA with 3 settings of shrinkage.

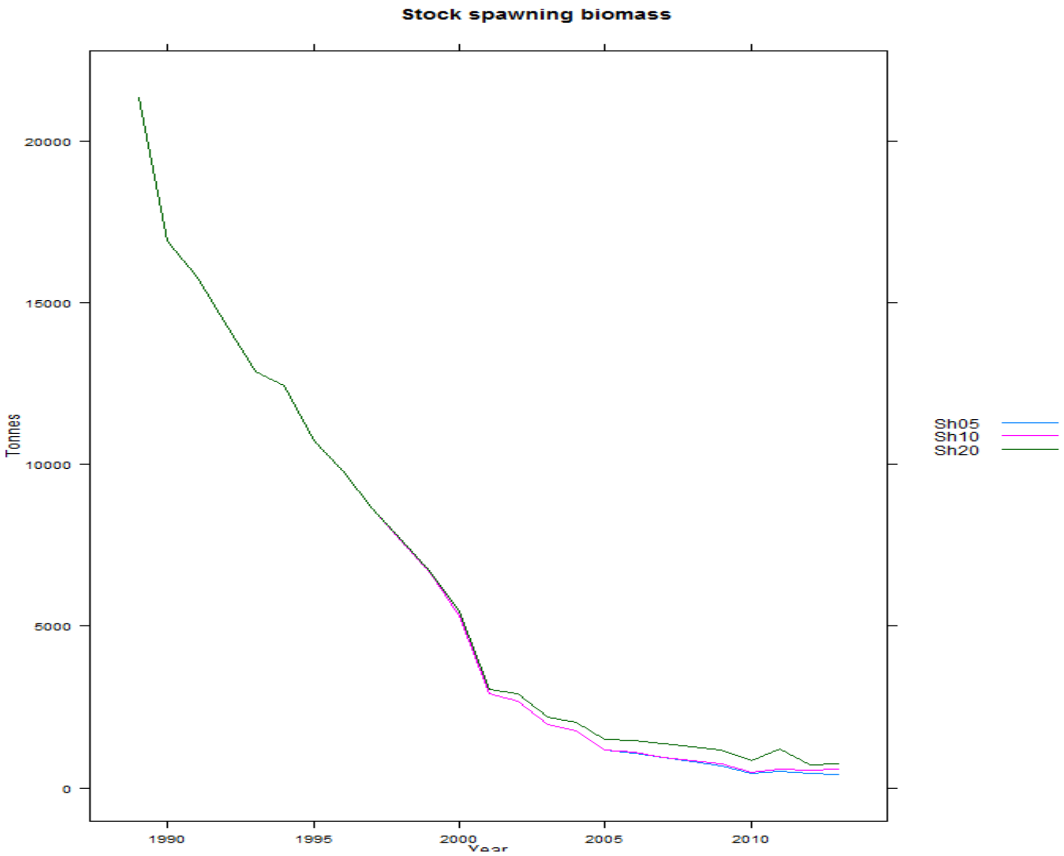


Figure 6.6.4.5.5 Spawning Stock Biomass estimated by XSA with 3 settings of shrinkage.

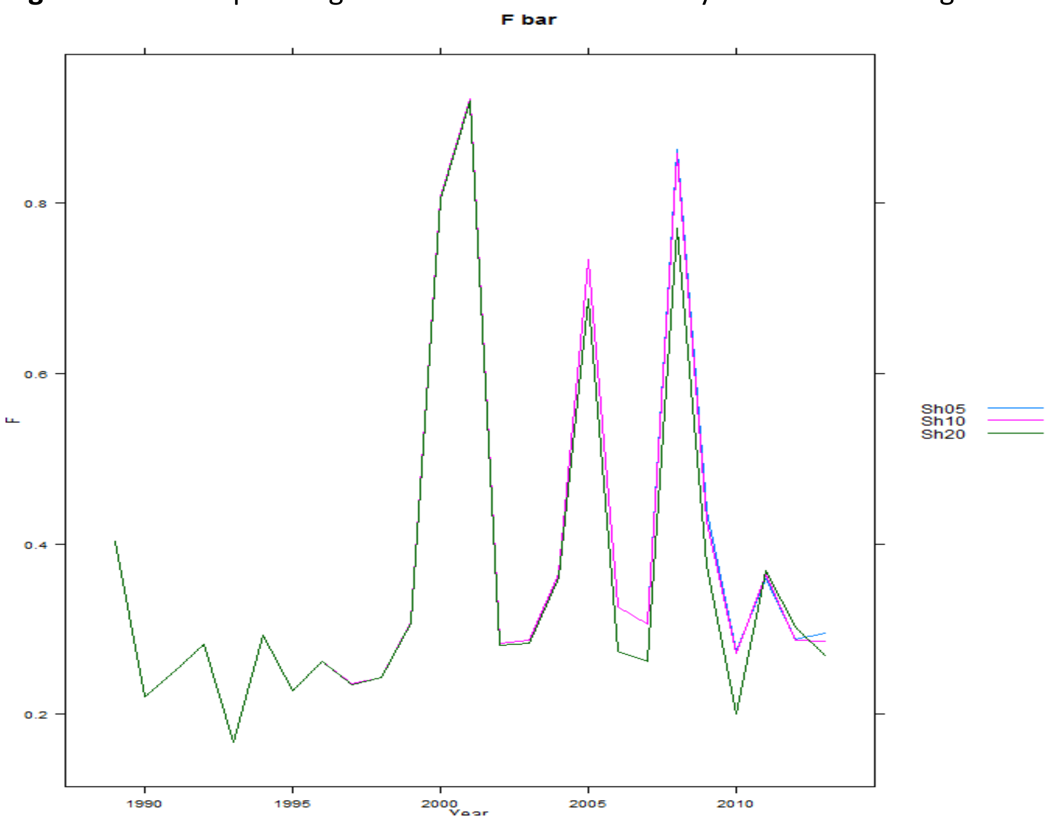


Figure 6.6.4.5.6 Fbar (ages) estimated by XSA with 3 settings of shrinkage.

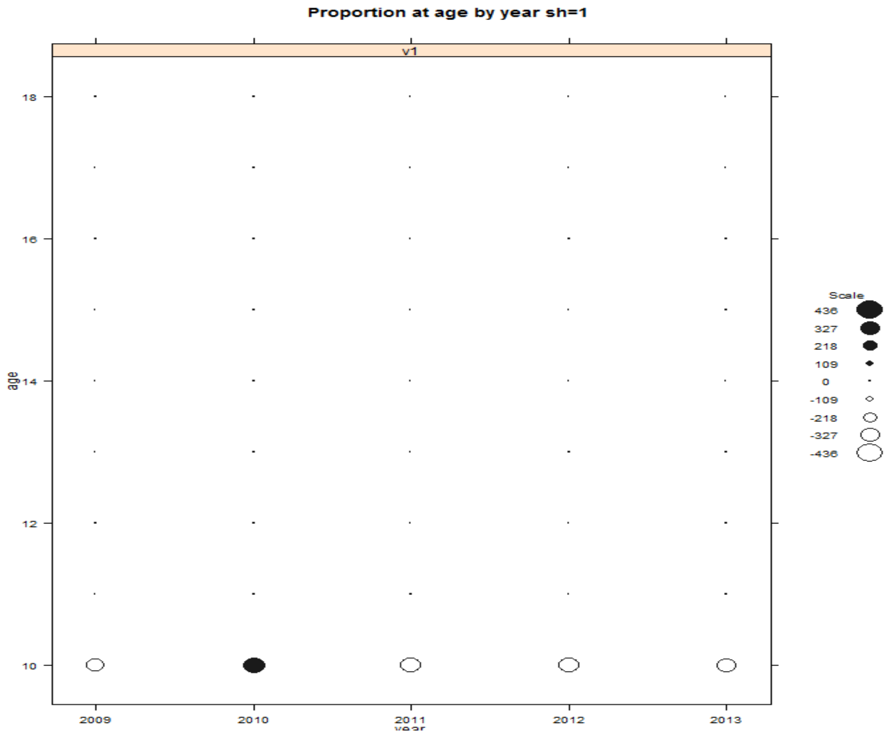


Figure 6.6.4.5.7 Residuals of tuning series applying a shrinkage of 1.

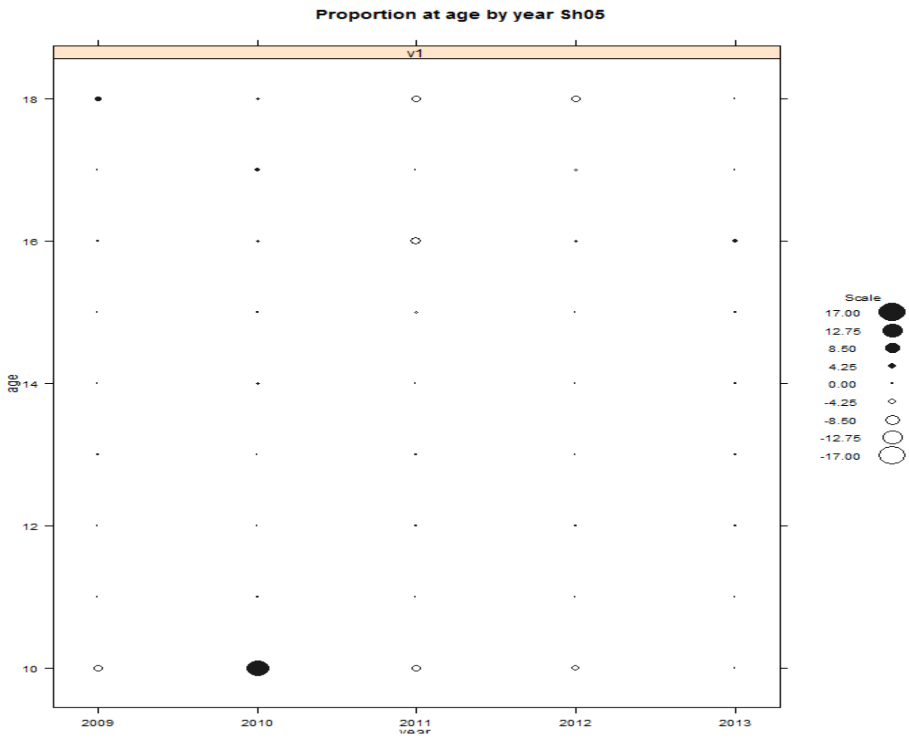
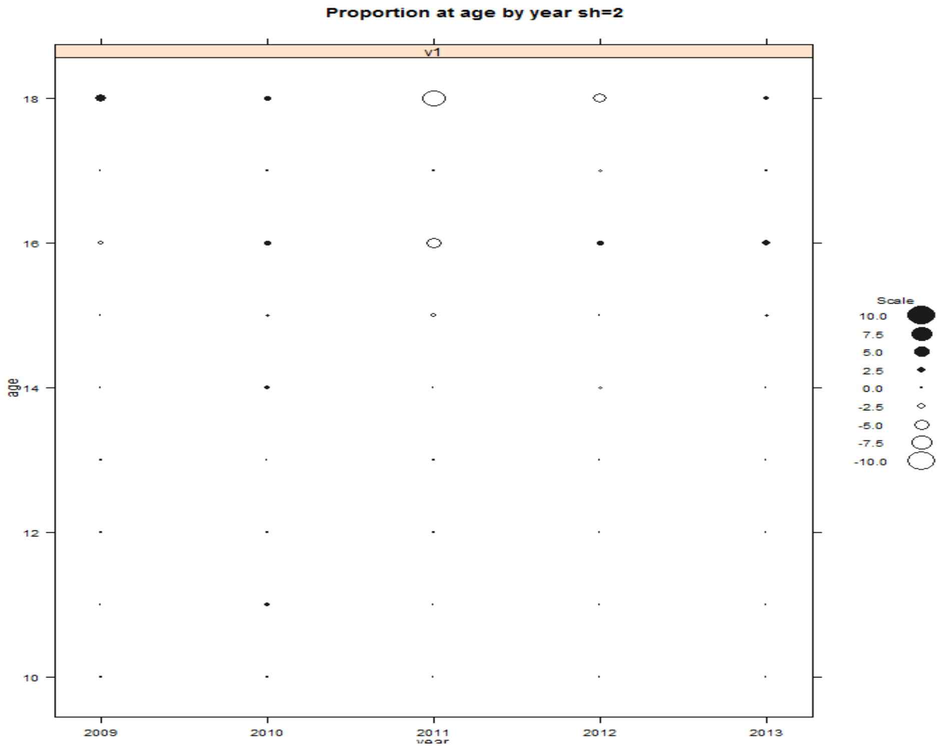


Figure 6.6.4.5.8 Residuals of tuning series applying a shrinkage of 0.5.



ure

Figure 6.6.4.5.9 Residuals of tuning series applying a shrinkage of 2.

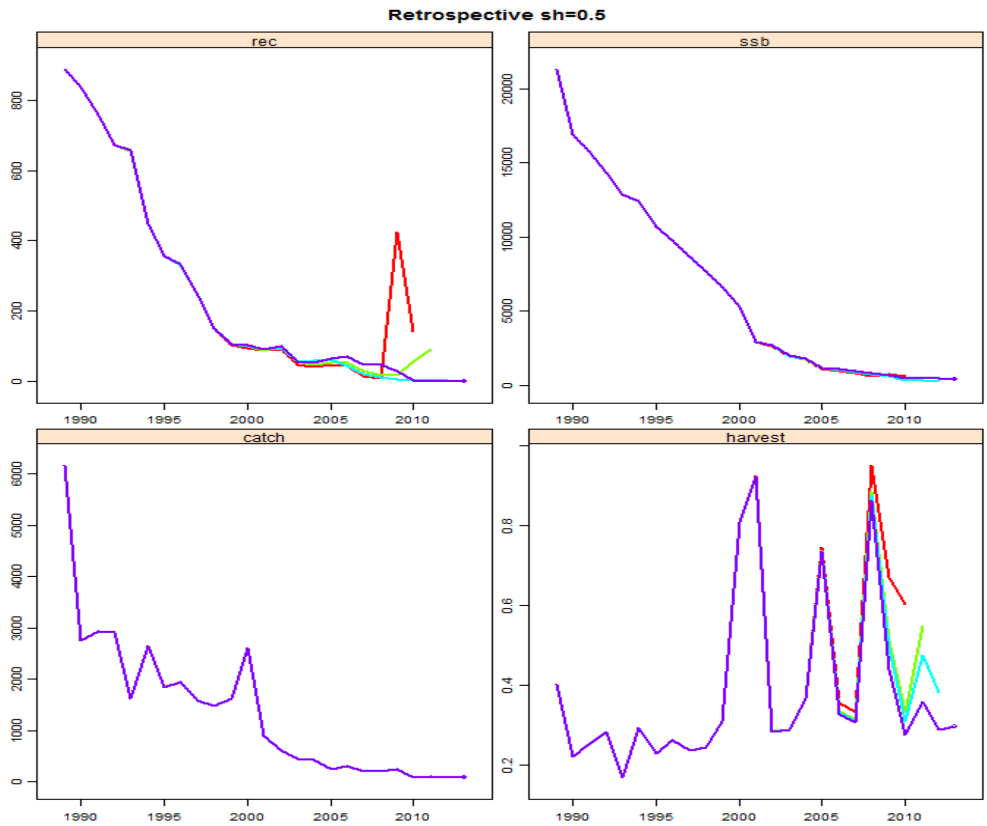


Figure **6.6.4.5.10** Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage 0.5.

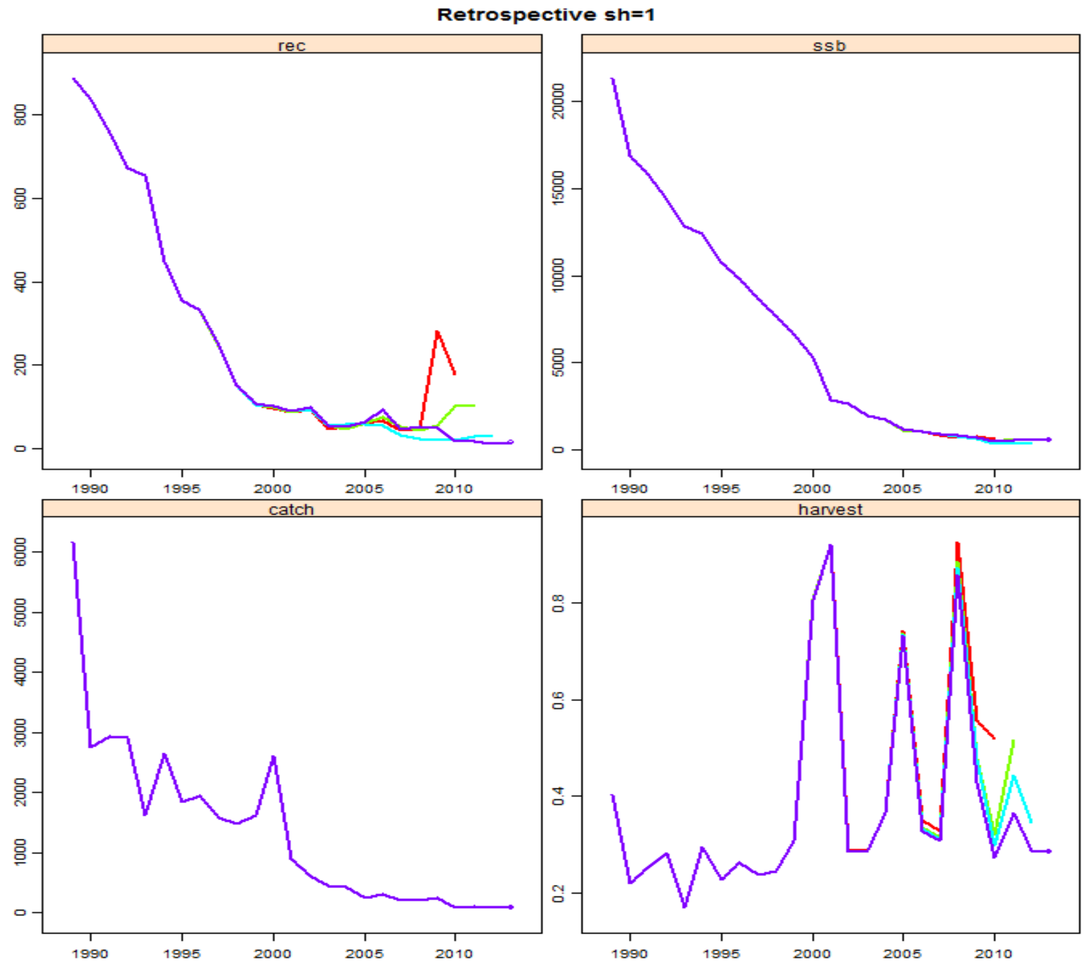


Figure 6.6.4.5.11 Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage 1.

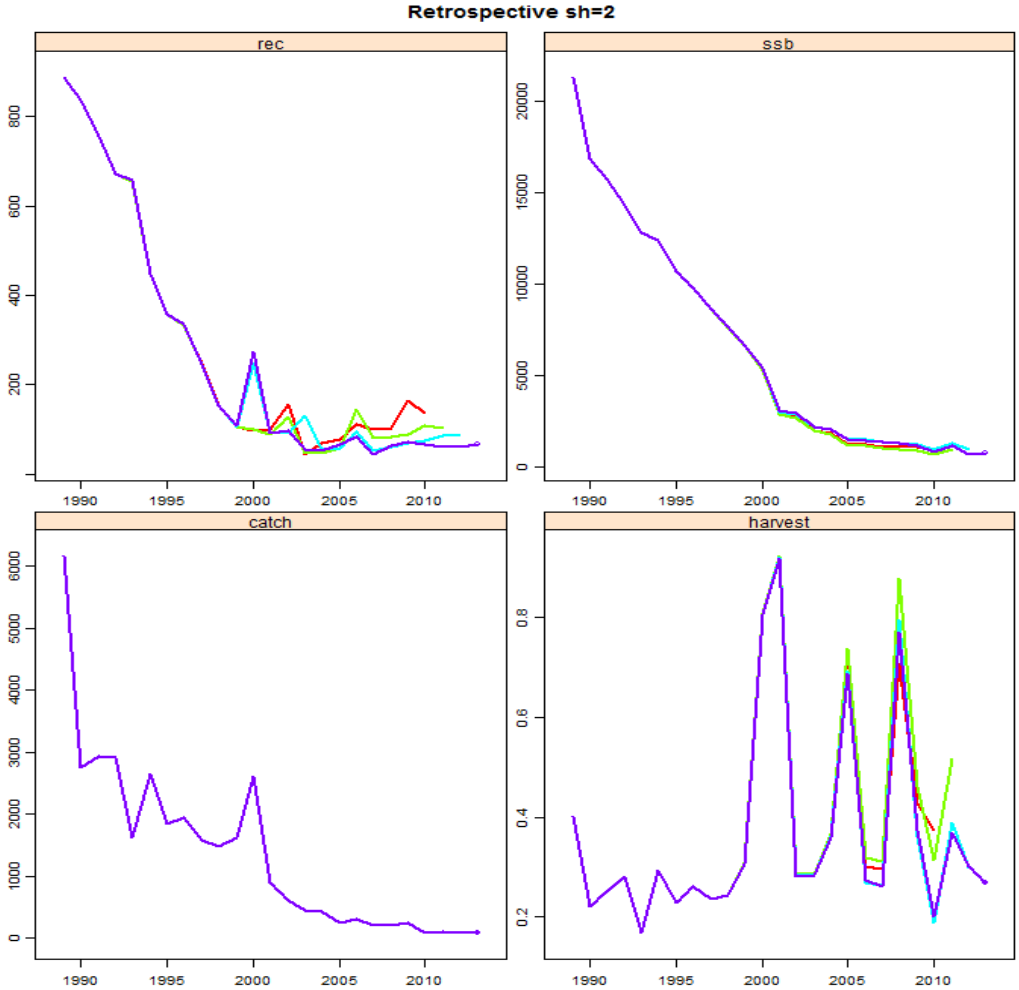


Figure 6.6.4.5.12 Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage 2.

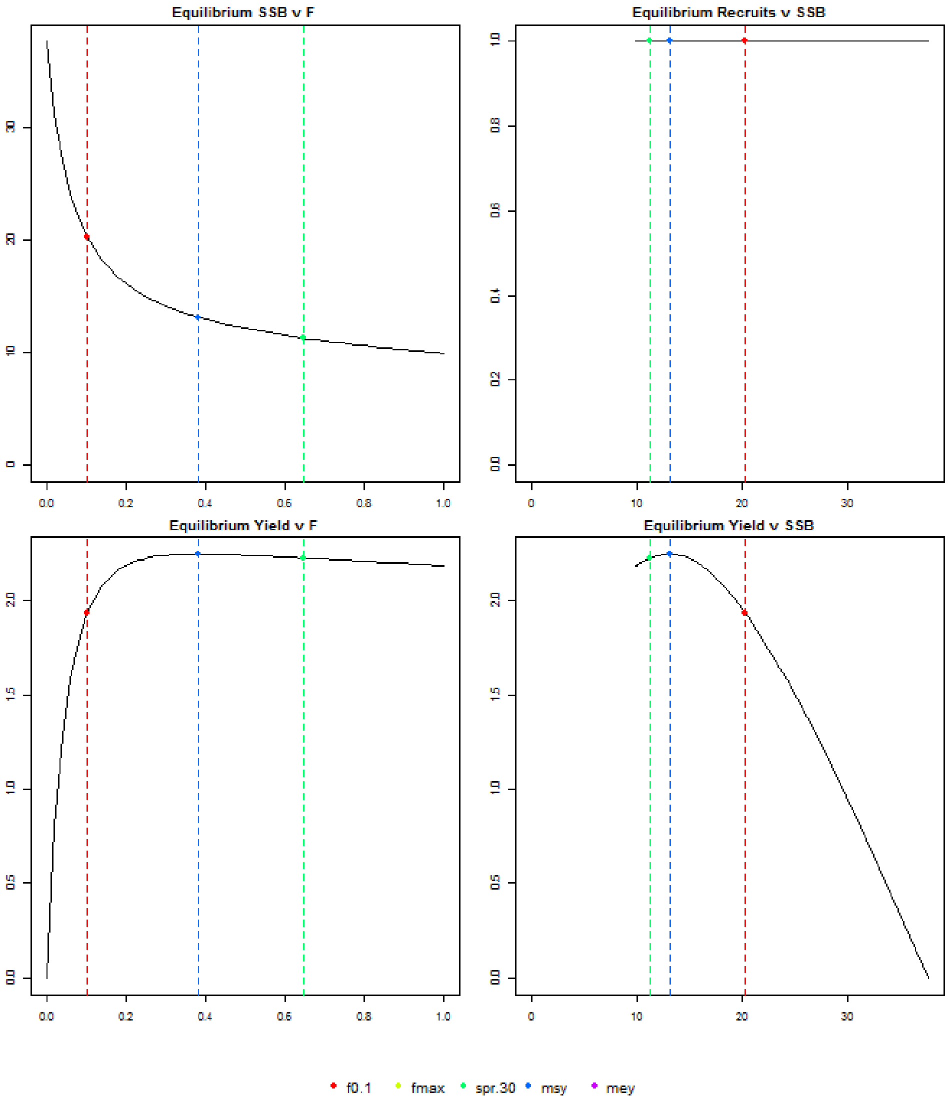


Figure 6.6.4.5.13 Yield per Recruit of Spurdog in the Black Sea.

Diagnostics of XSA best run on Black Sea Spurdog:

FLR XSA Diagnostics 2014-10-09 16:20:12

CPUE data from indices

Catch data for 25 years 1989 to 2013. Ages 7 to 19.

	fleet	first age	last age	first year	last year	alpha	beta
1	Commercial CPUE Bulgaria	10	18	2009	2013	<NA>	<NA>

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability independent of size for ages >   13

Catchability independent of age for ages >   17

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final   3 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk =   2

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age \ year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age \ year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
7	0.015	0.017	0.000	0.000	0.000	0.000	0.001	0.002	0.001	0.000
8	0.049	0.078	0.048	0.000	0.000	0.000	0.007	0.008	0.003	0.000
9	0.034	0.029	0.079	0.017	0.000	0.090	0.010	0.010	0.004	0.000
10	0.009	0.000	0.175	0.058	0.000	0.333	0.051	0.035	0.012	0.000
11	0.000	0.000	0.542	0.069	0.000	0.393	0.056	0.094	0.022	0.015
12	0.000	0.000	0.501	0.133	0.056	0.390	0.083	0.064	0.042	0.042
13	0.006	0.047	0.137	0.358	0.181	0.493	0.202	0.156	0.047	0.137
14	0.035	0.250	0.146	0.074	0.182	0.537	0.231	0.249	0.307	0.141
15	0.145	0.655	0.001	0.242	0.053	0.423	0.306	0.426	0.659	0.515
16	0.915	0.645	0.327	0.642	1.002	0.044	0.642	0.892	0.818	0.652
17	1.774	3.906	0.366	0.525	4.691	0.385	0.034	1.036	0.512	0.656
18	0.579	1.113	0.199	0.372	1.237	0.300	0.340	0.016	0.365	1.284
19	0.579	1.113	0.199	0.372	1.237	0.300	0.340	0.016	0.365	1.284

XSA population number (Thousand)

year \ age	7	8	9	10	11	12	13	14	15	16	17	18	19
2004	52	48	70	55	138	28	24	25	25	10	11	29	14
2005	66	44	39	59	47	119	24	20	21	19	3	2	0

```
  2006 83 56 35 33  50  40 102 20 14  9  8  0  0
  2007 44 71 46 28  24  25  21 77 15 12  6  5  0
  2008 63 38 61 39  23  19  19 13 61 10  5  3  1
  2009 70 54 32 53  33  20  15 14  9 50  3  0  0
  2010 67 61 47 26  33  19  11  8  7  5 41  2  0
  2011 59 58 52 40  21  26  15  8  6  4  2 34  9
  2012 61 51 49 44  33  16  21 11  5  3  2  1  0
  2013 66 52 44 42  38  28  14 18  7  2  1  1  1
```

Estimated population abundance at 1st Jan 2014

```
     age
year   7  8  9 10 11 12 13 14 15 16 17 18 19
  2014 0 57 45 37 37 32 23 10 13  4  1  1  0
```

Fleet: Commercial CPUE Bulgaria

Log catchability residuals.

```
    year
age    2009   2010   2011   2012   2013
  10  0.015  0.007 -0.012 -0.003 -0.007
  11 -0.358  1.445 -0.195 -0.415 -0.472
  12  0.013  0.010  0.027 -0.018 -0.032
  13  0.007 -0.001  0.008 -0.005 -0.009
  14 -0.444  1.468 -0.094 -0.689 -0.237
  15 -0.141  1.083 -1.344 -0.221  0.626
  16 -1.303  2.479 -6.143  2.116  2.828
  17 -0.005  0.444  0.293 -0.748  0.022
  18  3.964  2.028 -9.324 -5.163  1.340
```

Regression statistics
Ages with q dependent on year class strength

```
[1] "-0.0885920792129164" "0.450684056096441"
"0.250483624620364"
[4] "-0.209875796808922"  "3.42508906484448"    "4.59548067624483"
[7] "2.41415008692177"    "3.54162434533967"
```

Terminal year survivor and F summaries:

,Age 7 Year class =2006

```
source
    scaledWts survivors yrcls
fshk     0.052         7  2006
nshk     0.948        64  2006
```

,Age 8 Year class =2005

source

	scaledWts	survivors	yrcls
fshk	1	2	2005

,Age 9 Year class =2004

source

	scaledWts	survivors	yrcls
fshk	1	1	2004

,Age 10 Year class =2003

source

	scaledWts	survivors	yrcls
Commercial CPUE Bulgaria	0.978	39	2003
fshk	0.022	0	2003

,Age 11 Year class =2002

source

	scaledWts	survivors	yrcls
Commercial CPUE Bulgaria	0.418	11	2002
fshk	0.582	8	2002

,Age 12 Year class =2001

source

	scaledWts	survivors	yrcls
Commercial CPUE Bulgaria	0.977	20	2001
fshk	0.023	15	2001

,Age 13 Year class =2000

source

	scaledWts	survivors	yrcls
Commercial CPUE Bulgaria	0.975	11	2000
fshk	0.025	10	2000

,Age 14 Year class =1999

source

	scaledWts	survivors	yrcls
Commercial CPUE Bulgaria	0.8	10	1999
fshk	0.2	7	1999

,Age 15 Year class =1998

source
scaledWts survivors yrcls
Commercial CPUE Bulgaria 0.697 7 1998
fshk 0.303 4 1998

,Age 16 Year class =1997

source
scaledWts survivors yrcls
Commercial CPUE Bulgaria 0.106 18 1997
fshk 0.894 1 1997

,Age 17 Year class =1996

source
scaledWts survivors yrcls
Commercial CPUE Bulgaria 0.891 1 1996
fshk 0.109 1 1996

,Age 18 Year class =1995

source
scaledWts survivors yrcls
Commercial CPUE Bulgaria 0.026 1 1995
fshk 0.974 1 1995

Table 6.6.4.5.1 Results of XSA for Spurdog

Year	ssb	fbar	rec	catch	landings
1989	21327.5	0.403137	888.4916	6159.066	6159
1990	16900.89	0.220227	838.2069	2761.342	2761
1991	15790.01	0.250921	757.7806	2924.171	2924
1992	14337.04	0.281868	672.4678	2911.124	2911
1993	12852.6	0.167502	658.0868	1618.019	1618
1994	12425.23	0.293459	448.0273	2650.528	2650
1995	10720.23	0.227698	356.8775	1836.96	1837
1996	9810.904	0.261933	335.432	1950.854	1951
1997	8636.504	0.235532	247.0885	1585.398	1585
1998	7655.869	0.243234	151.8017	1482.224	1482
1999	6639.956	0.307669	108.0694	1628.968	1629
2000	5446.358	0.805687	273.7462	2601.601	2601
2001	3054.804	0.919883	91.54777	894.9765	895
2002	2921.907	0.280892	95.72033	601.5113	602
2003	2177.697	0.283799	55.57748	452.4222	452

2004	2028.456	0.360405	52.37006	421.4447	421
2005	1480.491	0.687951	65.97022	250.8492	251
2006	1449.457	0.274379	82.64084	302.5813	302
2007	1363.506	0.262536	43.85416	211.036	211
2008	1270.912	0.77065	63.19147	206.3849	206
2009	1171.017	0.374735	70.48022	235.2514	235
2010	847.8346	0.200707	67.3138	74.9921	75
2011	1188.978	0.368972	59.26857	104.268	104
2012	692.9493	0.302269	60.90922	77.8236	70
2013	755.7072	0.269752	66.35939	83.2188	83

6.6.5 Short term prediction of stock biomass and catch

6.6.5.1 Justification

The analysis of data show that the catches and biomasses decreased dramatically throughout the studied period. Historical analysis shows that the state of piked dogfish stock has been influenced not only by fishing which was at quite high level due to the bigger number of trawlers and high levels of the spiny dogfish by-catch.

The state of the species has also been influenced by ecological changes due to eutrophication and Mnemiopsis leiydi invasion and outburst in Black Sea. Comb jelly conquered with small pelagic fish for the food. Simultaneously, the small pelagic fishes are important trophic base for the dogfish in the Black Sea. We assume the decrease of the small pelagic stocks due to overexploitation and eutrophication processes which have a strong impact on the top predators including Elasmobranches in the Black Sea (BSC, 2008, Daskalov et all., 2009, 2011; Radu et all., 2011a,b; Shlyahov V. and Daskalov G., 2008).

6.6.5.2 Input parameters

The piked dogfish has been assessed using age-structured methods (Prodanov et al. 1997, Shlyakhov, 1997, Daskalov 1998). Fisheries, biological (age and individual size and growth), trawl survey data and commercial CPUE from all countries need to be thoroughly compiled.

6.6.5.3 Results

The fishing mortality rate during 2013 was estimated by VIT to be 0.112, below the estimated F0.1 = 0.204 proxy for F_{MSY}. XSA estimates of current rates of fishing mortality are high (~0.3) and estimates of F for past years were erratic, exceeding 0.7 four times during 1999 to 2009. Given (a) the uncertainty in the VIT and YPR-LEN analyses, linked to the assumption of constant recruitment, (b) the preliminary nature of the XSA analysis, and (c) the absence of more reliable information, the EWG considers it precautionary to use the F_{MSY} value (0.029) estimated by ICES for piked dogfish in the North East Atlantic as an appropriate proxy for F_{MSY} for piked dogfish in the Black Sea.

Taking into account that the current F fluctuates between 0.112 (VIT) and <0.1 (XSA) the results can be viewed as being uncertain but indicative of the status of piked dogfish. The stock can be considered to be overexploited or even severely depleted, if the precautionary F_{MSY} value is to be taken into account.

6.6.6 Medium term prediction of stock biomass and catch

Continuing to operate in the same manner, in the competitive system without management at the regional level will result in the collapse of the dogfish stock

6.6.7 Long term predictions

No long term predictions were undertaken.

6.6.8 Scientific advice

6.6.8.1 Short term considerations

The lack of a fishery independent scientific survey to monitor dogfish all over the Black Sea to indicate trends in total mortality and recruitment appears the major data deficiency in the assessmentAs in previous years, EWG 14-14 recommends such a survey to be established. Also age reading of dogfish needs to be calibrated between different national laboratories to avoid discrepancy between national catch-at-data.

It is very important the improvement of catch statistics regarding *Squalus acanthias* in the Black Sea area. Catch information is vital for the successful management of this species. Also, the joint surveys (6 Black Sea countries) are necessary to follow the distribution patterns, spawning areas, CPUE series, biomass estimations, diet, maturity indices etc. Nevertheless, XSA results indicated a steady and major reduction in the spawning stock biomass since 1989 and linked to the poor recruitment during the past couple of years there seems to be no indication of a stock recovery.

6.6.8.2 Medium term considerations

6.7 RED MULLET IN GSA 29

6.7.1 Biological features

6.7.1.1 Stock identification

The red mullet (*Mullus barbatus*) is a demersal species in the Black Sea and Azov ecosystem. Red mullet inhabits temperate and tropical waters in small schooling groups. It distributes on sandy-muddy or wholly muddy bottoms feeding on crustacean and small invertebrates. According to sea water temperature it makes seasonal migrations for spawning and feeding (Whitehead et al., 1986). The stock is vulnerable to fishery all year long. Furthermore, its delicious meat raises it economical value. According to Ivanov and Beverton (1985) red mullet is a gregarious, demersal species, found on muddy bottoms or gravels and sandy bottoms of the continental shelf between 5m and 100m depth. In the spring, at temperature of 7-8 ^{o}C, appears near of the shore; when the water is warming at 15-16 ^{o} C, going back to bigger depths. Reproduction occurs in the period June-September, on muddy or sandy bottoms, from 10m to 55m.

Red mullet is bottom benthic fish reaches a length of 20 cm and more, and the age of 10-12 years (Svetovidov, 1963), usually until 4–5 years old. Red mullet prefers waters with the temperature higher 8º C and salinity more than 17‰. Red mullet spawns in June - September, on muddy or sandy bottoms, from 10 m to 55 m with a maximum in mid-summer. Eggs and juveniles (up to the age of 1.5 months) are pelagic; adults live near bottom, feeding on *Polychaetae*, crustaceans and mollusks. In the vicinity of the Crimean and Caucasus coasts, it is customarily distinguished in two particular forms – "settled" and migratory ones. In the waters of Ukraine and the Russian Federation migratory form has the greater commercial value, moving to the Kerch Strait and the Sea of Azov for fattening and spawning in spring and coming back to the coasts of the Crimea for wintering. Along coasts of Romania and Bulgaria in September-November red mullet migrates to the Turkish waters of the Black Sea and Sea of Marmara for wintering. Some years it schools remain on the Bulgarian coast and die in cold winters.

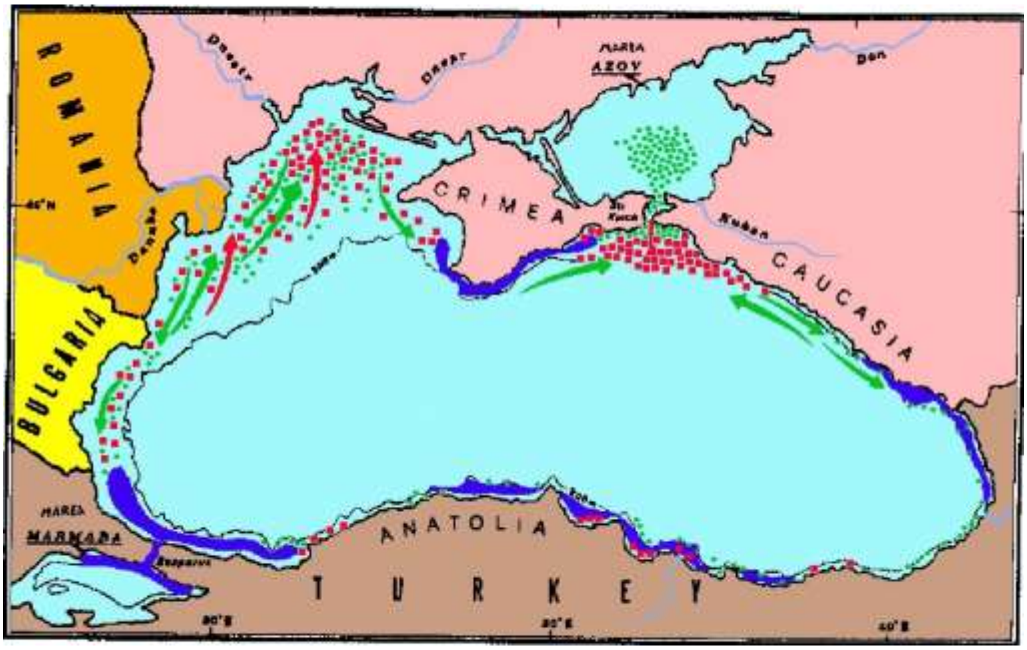
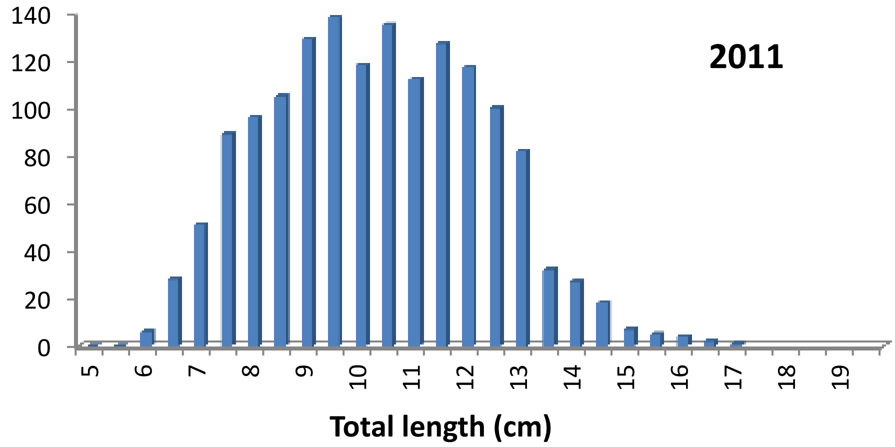


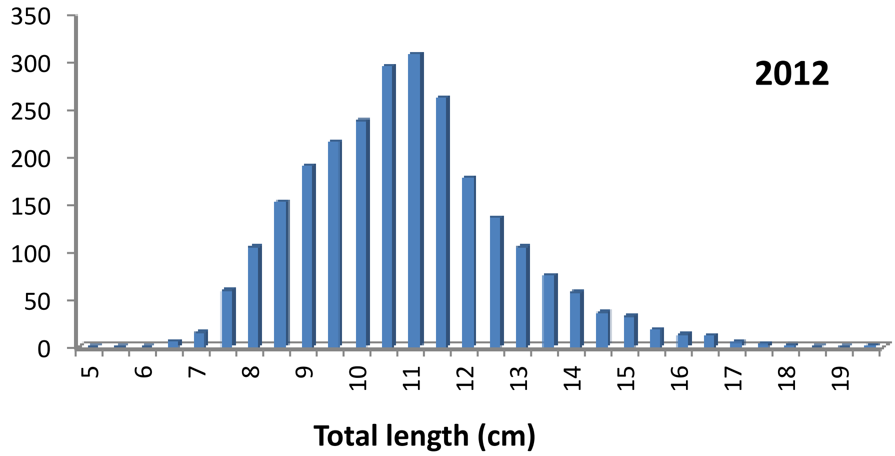
Figure 6.7.1.1.1. Migration routes, spawning, feeding and wintering areas for red mullet

In eastern Black Sea, a study about bio-ecological features of red mullet for 1991-1996 (Genç, 2000) reported that red mullet moves toward shallow waters to spawn in May and by the end of reproduction period (nearly August) it turns toward to 20-50 depths. By October-November it prefers deeper waters to spend the winter. At the end of reproduction period (August) recruitment is observed by 4-5 cm and 0+ age juveniles.

6.7.1.2 Growth - mortality

In south-eastern Black Sea; total lengths of the red mullet specimens ranged from 4.4 to 23.5 cm. Size ranges were 7.2-19.6 and 6.1-23.5 cm for males and females respectively, while mean total length values were estimated as 12.49 ±0.02 cm for whole population, 12.43±0.02 cm for males and 13.73±0.03 cm for females. Size differences between the sexes seemed to be significant in favour of females for the years 1991-1996 Genç (2000) and Süer (2008) reported that specimens of 9.5-14.5 cm are composing 73.5% of the samples in 2004-2006, the minimum length been 5.9 cm and the maximum length 22.6 cm. Zengin et al (2012) reported a length range of 5.5-20.1 cm with average of 10.47 cm along southern Black Sea coast. The length frequency distributions of red mullet in 2011-2013 along southern Black Sea coast were presented in Figure 6.7.1.2.1.





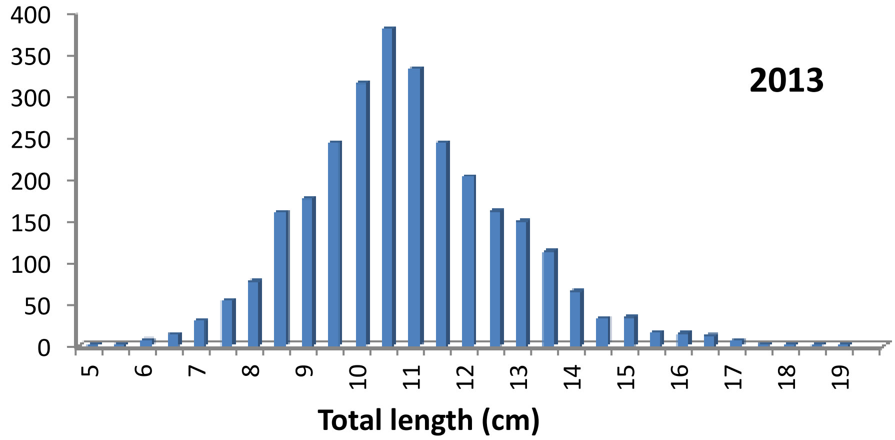


Figure 6.7.1.2.1. Length frequency distributions of red mullet along southern coast of Black Sea for 2011-2013.

Sex ratio in whole population is around 1:1, however, the ratio seems to vary between age and size groups. Males are dominant during the early ages, but after age of 3 and size of 14.5 cm, ratio change in favour of females. Maximum age is 9 years for females and 8 years for males. Fish from 0^+, 1^+ and 2^+ age groups consist of approximately 80% of the population. Genç (2000) and Süer (2008) determined that the sex ratio (M:F) was 1.55:1, 1.65:1 and 1.86:1 for 2004-2006 respectively.

The longevity of red mullet was identified as six years with dominant age classes of age 2 (46.2%) and 1 (24.8%). Zengin et al. (2012) estimated the sex ratio of 0.77:1 in 2010-2012. The average age composition of red mullet population from various studies conducted in Turkish Black Sea coasts is presented in Table 6.7.1.2.1. Gumus et al. (2013) recorded that the M:F ratio of the population was as 0.54:1 in 2013. The length range was between 5.2 cm and 19.2 cm at age range of 0 - 5 years. The average length and weight were 11.16 cm and 15.77 g, respectively. The most dominant age group was 1 year old, followed by the 2 year olds. The growth parameters and regression coefficients for L-W relationship are presented in Table 6.7.1.2.2.

Table 6.7.1.2.1. The distribution of the population according to age groups in different studies in the Black Sea.

Researchers	**Age groups**									
	0+	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Samsun and Erkoyuncu (1992)	-	50,43	21,36	19,14	7,51	1,13	0,43			
Şahin and Akbulut (1997)	-	34,69	31,15	14,59	8,42	6,25	4,89			
Genç(2000)	12.57	28.63	38.79	15.94	3.36	0.56	0.11	0.01	0.03	0,01
Genç(2002)	0,71	16,84	52,23	27,18	2,42	0,43	0,19			
Süer(2008)	10,4	24,8	46,2	15,2	2,5	0,6	0,1			
Aydın and Karadurmuş(2013)		10,66	39,86	35,89	7,39	4,18	1,11	0,91		
Zengin et al (2012)	14.2	49.2	22.3	8.6	4.9	0.3	0.1			
Gumus et al (2013)	6.5	56.4	26.6	7.4	2.9	0.2				

Table 6.7.1.2.2. Parameters of VBGF and L-W relationship for red mullet calculated in the Black Sea

COUNTRY	YEAR- PERIOD	SPECIES	SEX	L_INF	K	t_0	A	b	Reference
Ukraine	1988-1990	MUT	C	17.97*	0.316	-1.876	0.0085	3.338	Domashenko (1990)
Turkey	1991-1996	MUT	F	25.55	0.238	-1.324	0.0064	3.177	Genç (2000)
	1991-1996	MUT	M	23.83	0.227	-1.624	0.0074	3.114	Genç (2000)
Turkey	2004-2006	MUT	M	25.25	0.154	-1.59	0.07	3.17	Süer (2008)
Turkey	2004-2006	MUT	F	39.36	0.082	-1.92	0.07	3.14	Süer (2008)
Turkey	2004-2005	MUT	C	20.15	0.33		0.0107	2.9717	Aksu et al, 2011
Turkey	2010	MUT	C	18.97	0.486	-0.961	0.007	3.15	Zengin et al.(2012)
Turkey	2011	MUT	C	20.66	0.442	-1.327	0.007	3.15	Zengin et al.(2012)
Turkey	2012	MUT	C	21.37	0.409	-1.479	0.006	3.21	Zengin et al.(2012)
Turkey	2013	MUT	C	21,97	0,287	-1,086	0,008	3,11	Gumus et al (2013)
Romania	2013	MUT	C	12.63	0.411	-2.273	0.005	3.27	NDCP, 2013

* - standard length (SL)

Table 6.7.1.2.3 reveals the data from various studies regarding mortality and exploitation rates of red mullet population. According to various authors in the period 1991-1996, total mortality rates (Z) ranged from 1.16 to 1.51, natural mortality rate (M) 0.36-0.44, and fishing mortality (F), 0.62-1.08 while overall mean values are calculated as Z=1.41, M=0.39 and F=1.02. Estimated total biomass values in entire eastern Black Sea were 1329, 3011 and 4850 tons during 1990-1992, respectively. Selectivity values (L_{50}) have been calculated as 12.57, 13.19 and 13.77 cm for trawl with cod-end mesh sizes of 18, 20 and 22 mm, respectively (Genç, 2000). Aksu et al. (2011) reported some population parameters of red mullet from southern-middle Black Sea for the years of 2004-2005 as $W=0.0107L^{2.9717}$, L_{inf} =20.15, K=0.33, M=0.68 and F=0.60. The natural mortality was estimated as 0.581 and 1.087 for TR and RO samplings in 2013, respectively (Gumus et al., 2013; NDCP, 2013)

Table 6.7.1.2.3. Mortality and exploitation rates of red mullet population

			Mortality	**Exploitation rate**	**Sampling year**
	Total mortality (Z)	Natural mortality (M)	Fishing mortality (F)	(E)	
Bingel *et al.* (1996)	6.17	0,92	5.25	0,80	1991
	5.97	0,91	5.06	0,80	1992
Genç (2000)	1,41	0,36	1,05	0.74	1991
	1,42	0,43	0,99	0.70	1992
	1,51	0,43	1,08	0.72	1993
	1,16	0,44	0,72	0.62	1994
	1,41	0,41	1,00	0.71	1995
	1,36	0,39	0,97	0.71	1996
	1,41	0,39	1,02	0.72	1991-96
Genç *et al.* (2002)	2,30	0,37	1,93	0,84	2000
Aksu *et al.* (2011)	1,28	0,68	0,60	0,47	2004-2005
Zengin et al (2012)	1.463	0.661	0.802	0.55	2010-2012

In Ukrainian waters; there are differences in the growth between settled and migratory forms of red mullet. The migratory form has a higher growth rate. The parameters of VBGF, the length-weight relationships and natural mortality M were estimated by Domashenko (1990).

Migratory form: K= 0.316 t_0= -1.876; SL_∞= 17.97 cm; W_∞= 100.5 g

$W= 0.0085 \times L^{3.338}$; M = 0.8

Length-based Cohort Analysis (LCA Jones method) has been performed in Ukrainian waters of the Black Sea in 2000-2012 The results show (Table 6.7.1.2.4) that average fishing mortality have increased but not as high as the reference level of $F_{0.1}$=0.6. In the period 2010-2012 the average fishing mortality of 0.566 comes close to $F_{0.1}$.

Table 6.7.1.2.4. Fishing mortality of red mullet in Ukrainian Black Sea waters in 2000-2012

					F_i
Sl_i. mm	**2000-2002**	**2003-2005**	**2006-2008**	**2009-2011**	**2010-2012**
61-65	0.000	0.000	0.000	0.000	0.000
66-70	0.000	0.000	0.001	0.000	0.000
71-75	0.001	0.000	0.007	0.002	0.002
76-80	0.002	0.001	0.014	0.023	0.006
81-85	0.016	0.013	0.036	0.073	0.029
86-90	0.085	0.053	0.128	0.273	0.080
91-95	0.136	0.079	0.237	0.501	0.096
96-100	0.278	0.141	0.335	0.505	0.184
101-105	0.437	0.232	0.412	0.734	0.271
106-110	0.414	0.312	0.506	0.962	0.354
111-115	0.453	0.377	0.544	0.934	0.397
116-120	0.467	0.449	0.609	1.016	0.484
121-125	0.695	0.619	0.605	0.767	0.563
126-130	0.756	0.561	0.658	0.727	0.618
131-135	1.006	0.557	0.689	1.894	0.690
136-140	1.177	0.572	0.700	1.774	0.754
141-145	1.269	0.515	0.747	2.394	0.877
146-150	3.334	0.749	0.808	1.948	0.928
151-155	2.703	0.590	0.750	2.703	1.141
$Fav._{91-155}$	0.161	0.121	0.174	0.257	0.566

6.7.1.3 Maturity

In eastern Black Sea Genç (2000) reported that the first sexual maturity is attained at 10.17 cm in males and 11.28 cm in females. In general, fish of these sizes are at age of one. Red mullets in this region spawn from end of May up to beginning of August. Spawning take place in surface layers of above 20 m at 18-25°C, salinity of 17-18‰ and dissolved oxygen concentrations of 6-9 mg/L. Mean size of ovulated egg ready for release has been measured as 756±2.21 (545-1050) µ and average relative fecundity is 149.7±8.97 eggs/g.

In Ukraine, the migratory form of red mullet matures at ages of 1+ (the main part recruitments of the spawning stock) or 2+ (Sirotenko.and Danilevsky, 1979). In the Sea of Azov red mullet not breed. Even if red mullet at ages of 1+ with maturing gonads come into the Sea of Azov, it will be absorbed.

6.7.2 Fisheries

6.7.2.1 General Description

Red mullet is one of the most important fish species fished and consumed traditionally in the Black Sea countries. In Turkey, it is mostly caught by bottom trawls as a target fish species. Red mullet is the second species after whiting composing 9.5% of total demersal catches between 1991 and 1996 (Genç, 2000). The gillnets are also allowed in red mullet fishery all along Turkish coasts and through all seasons but only 10% of total landing obtained by this method.

Catches of red mullet in EU waters are taken primarily by Bulgaria (131.5 t during 2012, 19% of the Black Sea total), with only small amounts landed by Romanian fishers (1.4 t during 2012, about 0.2% of the Black Sea total).

In the waters of Georgia according to the data of official statistics in 1989 – 1996 catches of red mullet were absent or was categorized within the "other fish" group. In 1997 – 2005, its mean annual catch was equal to 28 tons. According to Komakhidze *et al.* (2003), the red mullet was captured recently in higher amounts that provided an indirect evidence of increasing abundance.

Along the coasts of the Russian Federation target fisheries of red mullet are performed mainly with passive fishing gears. The stocks exceeded over 100 tons by 1998 which was mainly related to the reduction of *Mnemiopsis leidyi* population (Volovik and Agapov, 2003). In 2002, the total biomass was estimated at 1200 tons, exploited biomass at 960 tons and TAC at 200 tons.

In Ukrainian waters, target fishing of the red mullet was permitted only with beach seines and bottom set traps; however, the greater part of its catches corresponded to the non-target fishing with bottom traps (Shlyakhov and Charova, 2003). The major share of red mullet was harvested in autumn in Balaklava Bay, near Sebastopol. The amount of non-registered catches of red mullet cannot be evaluated at present. Spawning stock biomass (SSB), recruitment (R) and TAC of red mullet estimated with LCA are in Ukrainian waters are presented in Fig 6.7.2.1.1. In Ukraine a catch quota was set in 2013 for red mullet in the amount of 122 tons.

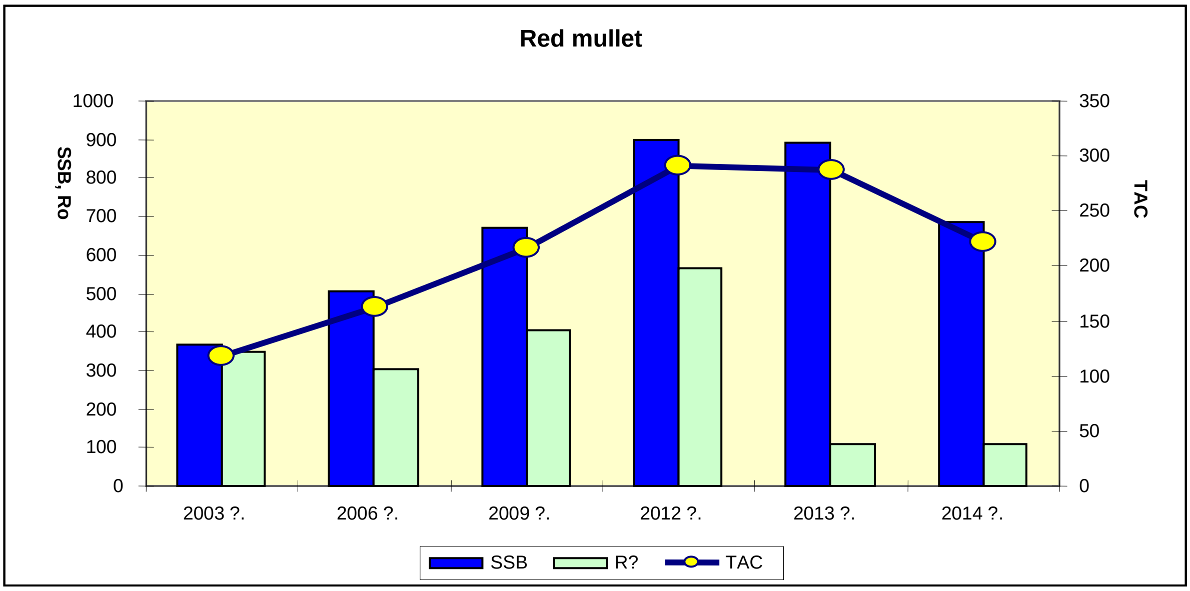


Fig 6.7.2.1.1 Jones method results for Crimean stock of red mullet in Ukrainian waters of the Black Sea for 2003-2012 and prediction for 2013-2014.

6.7.2.2 Management regulations applicable in 2012 and 2013

In Turkey the red mullet fishery is regulated by area and season closures of the fisheries:

(1) Area closures: Bottom trawling is prohibited in waters between a) Sinop city. İnceburun (42° 05.959' N-34° 56.695' E) and Samsun city Çayağzı cape (41° 41.040' N-35° 25.193' E), b) Ordu city; Ünye. Taşkana cape (41° 08.725' N-37° 17.531' E) and Georgia border. Furthermore, it is also banned within 2 miles from land between Zonguldak city; Ereğli. Baba cape (41°

17.342' N-31° 23.937' E) and Bartın city; Amasra. Tekke cape (41° 43.485' N-32° 19.258' E) (Figure 1). In other areas open to trawling allowed distance is 3 miles.

(2) Time closures: In open areas, red mullet fishery with bottom trawling is banned between April 15 and September 15. Gillnets were allowed all along the Turkish coasts for red mullet fishery except April 15-June 15.

(3) Mesh size limitations: Cod end mesh size should not be lower than 40 mm in bottom trawl nets.

(4) Minimum legal catch size: Minimum legal size (total length) was determined as 13 cm for all kind of fishing gears.

In Ukraine fisheries regulations set the minimum commercial fishing size for red mullet as 8.5 cm (SL); the allowable by-catch of juveniles in non-target fishery to be no more than 8% of the total weight of a haul and in target fishery – no more than 20% of the catch. The mesh size in beach seines and in scrapers should not be less than 10 mm.

Bottom-trawling is prohibited in Bulgaria. Closed season for all coastal fisheries is between 15 April to 15 June.

Minimum landing size of red mullet in the Black sea region are presented in Table. 6.7.2.2.1

Table. 6.7.2.2.1 Minimum landing size of red mullet in the Black sea region

	BG	GE	RO	RU	TR	UKR
Mullus barbatus	TL=12cm	SL=8.5cm	no	SL= 8.5 cm	TL=13.0	SL=8.5cm

6.7.2.3 Catches

6.7.2.3.1 Landings

Landings of the red mullet in the Black Sea were reported by the Black Sea countries (Table 6.7.2.3.1.1.) and some particular data from Ukraine. General trends in amount of landings appear different for countries (Figure 6.7.2.3.1.1). Landings significantly decreased by fluctuations in the last 15 years in Turkish data where a remarkable increase arise in Bulgarian catch in 2011. Ukraine and Russian catches of red mullet were relatively constant for the last ten and twenty years respectively.

Table 6.7.2.3.1.1 Red mullet landings (tons) in the Black Sea.

Years	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
1988				129		
1989				324		
1990				132		
1991				210		
1992				37		
1993				2		
1994				25		
1995				324		
1996				76	2249	
1997				68	1173	
1998				119	1423	
1999				92	1853	
2000	5.0			127	910	10.3
2001	26.0			119	1110	20.9
2002	33.0			47	867	40.7

2003	36.0			177	506	35.8
2004	17.0			99	668	23.0
2005	1.0			151	1093	17.5
2006	6.0			140	960	56.1
2007	12.5			87	781	54.4
2008	17.0			115	706	48.9
2009	48.2			291.65	799	65.2
2010	72.4			200.28	507	68.2
2011	176.2	22	1.9	290.94	326.1	58.2
2012	131.5		1.37	144.4	347.3	78.9
2013	**256.8**		**2.5**	**180**	**318.2**	**92**

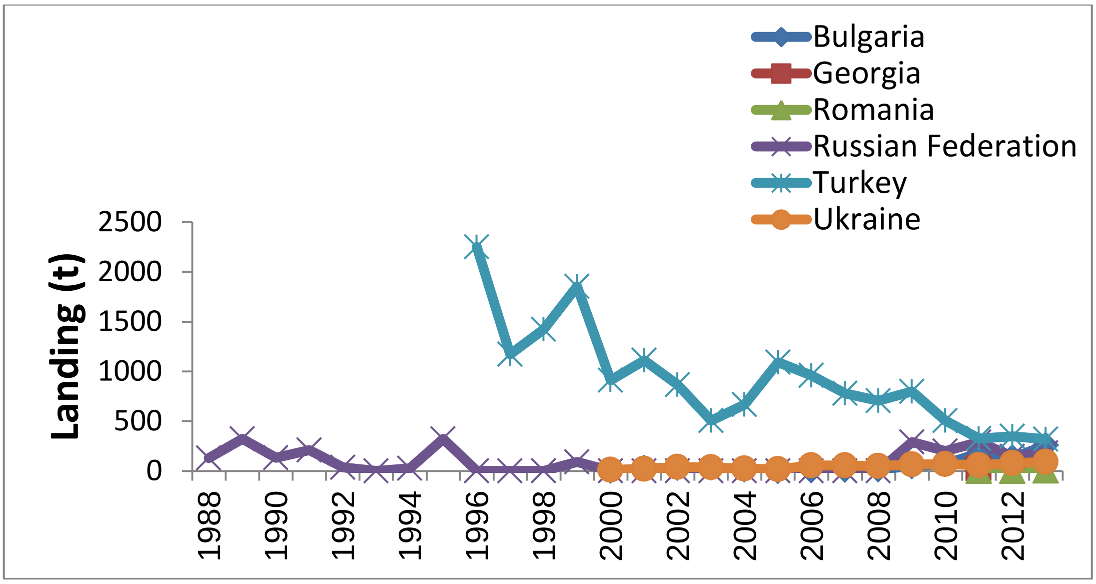


Figure 6.7.2.3.1.1 Trends in landing of red mullet in Black Sea countries

6.7.2.3.2 Discards

No information has been presented at the EWG 13-12 meeting

6.7.2.4 Fishing effort

No information has been presented at the EWG 13-12 meeting

6.7.2.5 Commercial CPUE

No information has been presented at the EWG 13-12 meeting

6.7.3 Scientific surveys

6.7.3.1 CPUE and CPUA indices

The mean catches per unit effort (CPUE) and abundance index (CPUA) are estimated respectively as 7.75 kg/km^2 and 16.58 kg/km^2 (Table 6.7.3.1.1.). Trawl samplings conducted is generally below of 40 m (minimum 24.7 m, maximum 113.0 m) depths along in the SSA and WBS littorals zones. The stock is localized under the layer of 30-50 m generally. The surveys period includes 7 months (from January to April and from September). Abundance indices were estimated by 'swept area method' from commercial vessels (Sparre and Venema, 1992). Biomass indices of pooled data by mapping two parts of Turkish Black Sea are given in figure 6.7.3.1.2).

Table 6.7.3.1.1. Descriptive data regarding CPUE (kg/h) and abundance indices CPUA (kg/km^2) of red mullet for 2012 and 2013 in the Samsun shelf area- (SSA) and West Black Sea.

	Region	Number of hauls	Minimum	Maximum	Mean	Std.E.of mean	Std. Dev.
2012	**CPUE/SSA**	60	0.00	37.90	7.70	1.31	10.14
	CPUE/ WBS	44	0.00	53.30	7.82	1.84	12.19
	CPUA/ SSA	60	0.00	80.00	15.97	2.82	21.87
	CPUA/WBS	44	0.00	125.00	17.41	4.33	28.74
2013	**CPUE/SSA**	42	0.00	40.00	12.89	2.11	13.65
	CPUE/ WBS	65	0.00	55.00	5.9	1.09	8.81
	CPUA/ SSA	42	0.00	300.00	78.74	13.93	90.26
	CPUA/WBS	65	0.00	265.00	33.69	5.98	48.21

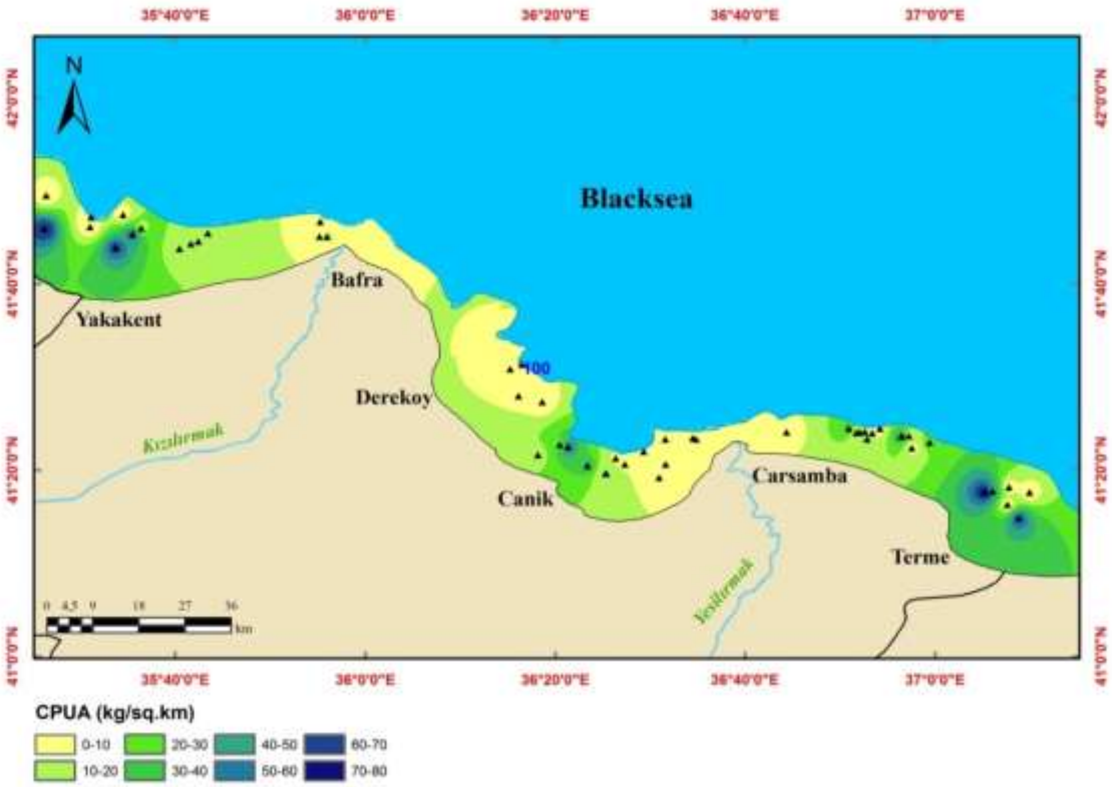
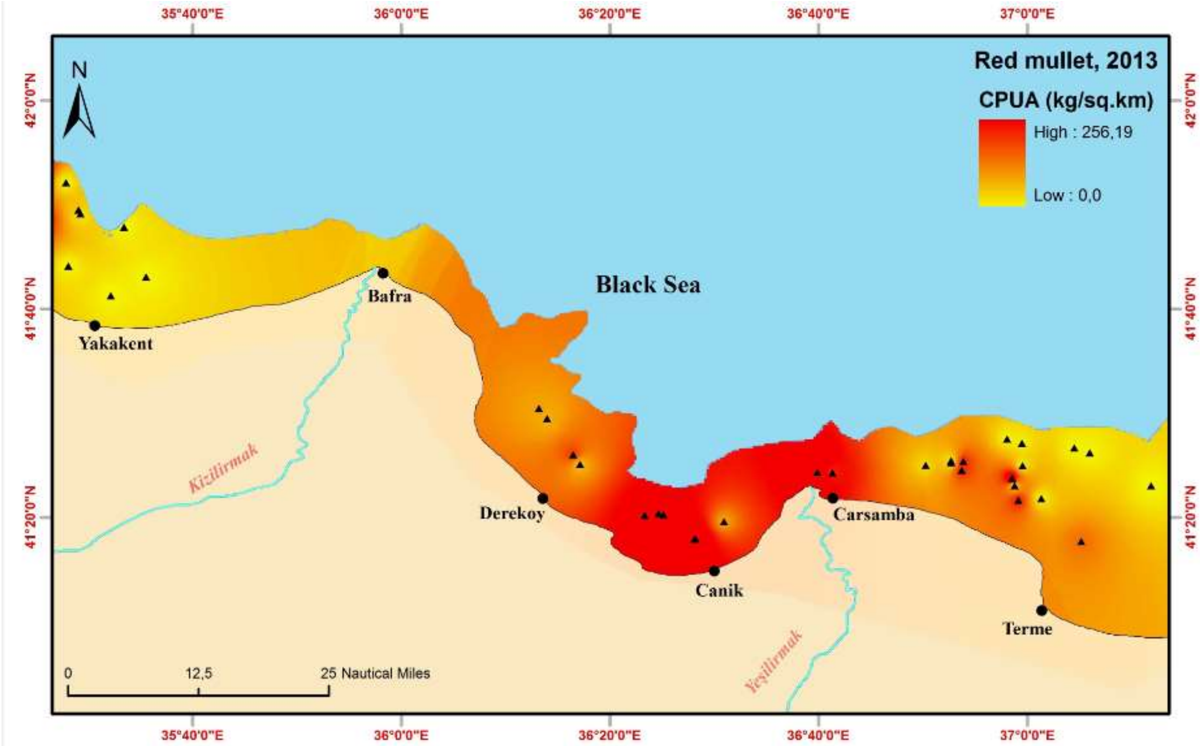


Figure 6.7.3.1.1. Map of biomass indices in the Samsun Shelf Area (upper) and West Black Sea (lower) for 2012 (This mapping is coverage all data).



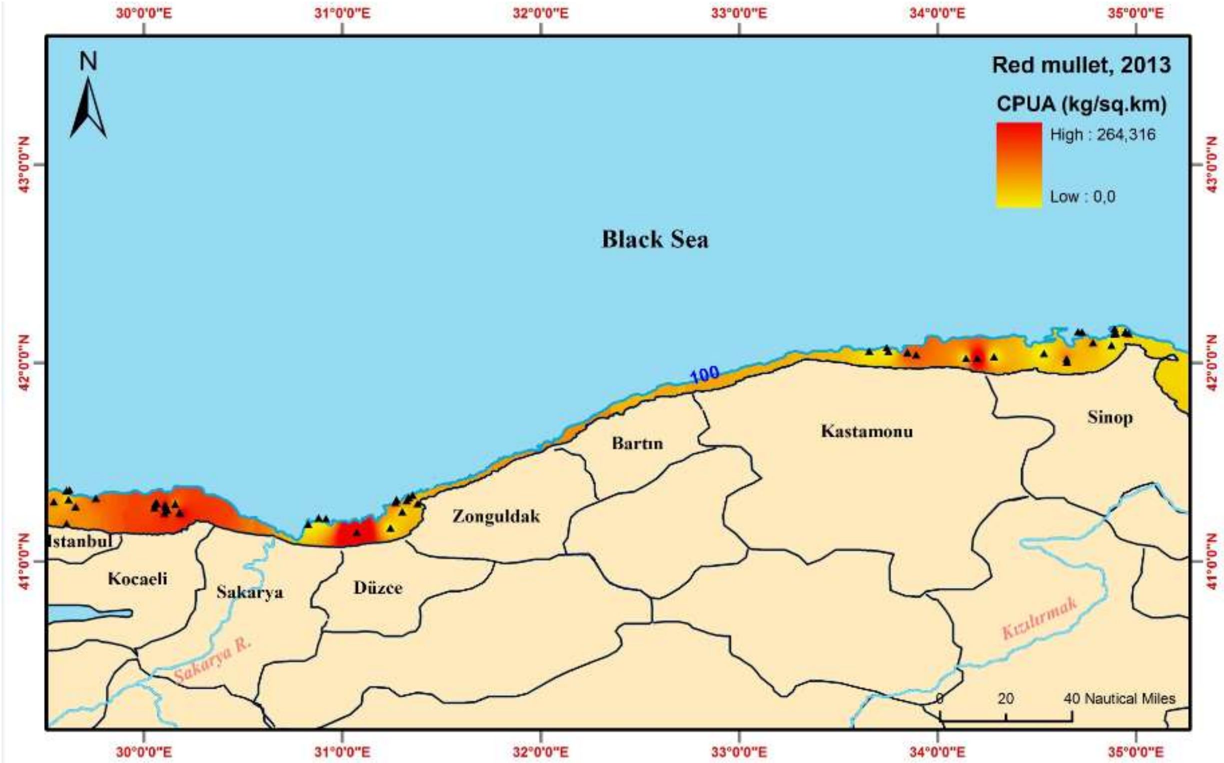


Figure 6.7.3.1.2. Map of biomass indices in the Samsun Shelf Area (upper) and West Black Sea (lower) for 2013.

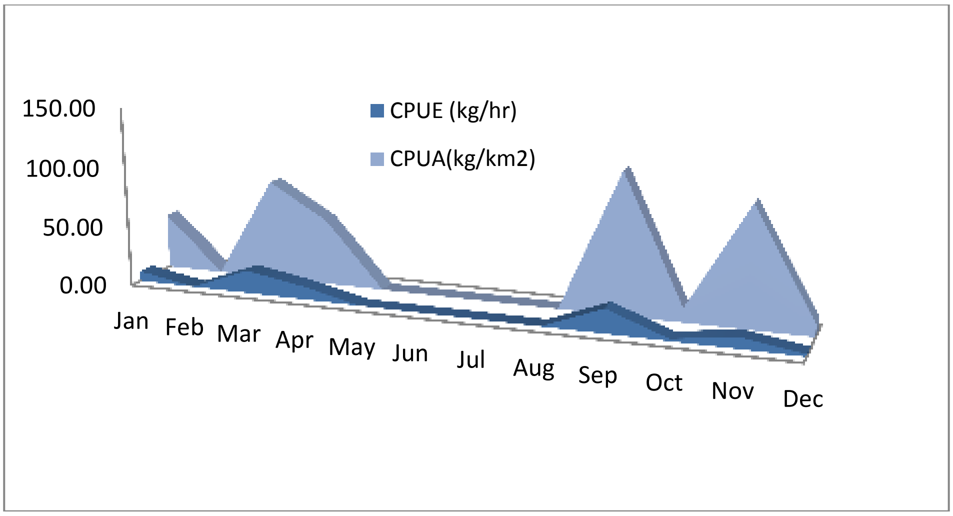


Figure 6.7.3.1.3. Monthly variation of CPUE and biomass data of red mullet along Turkish coasts for 2013.

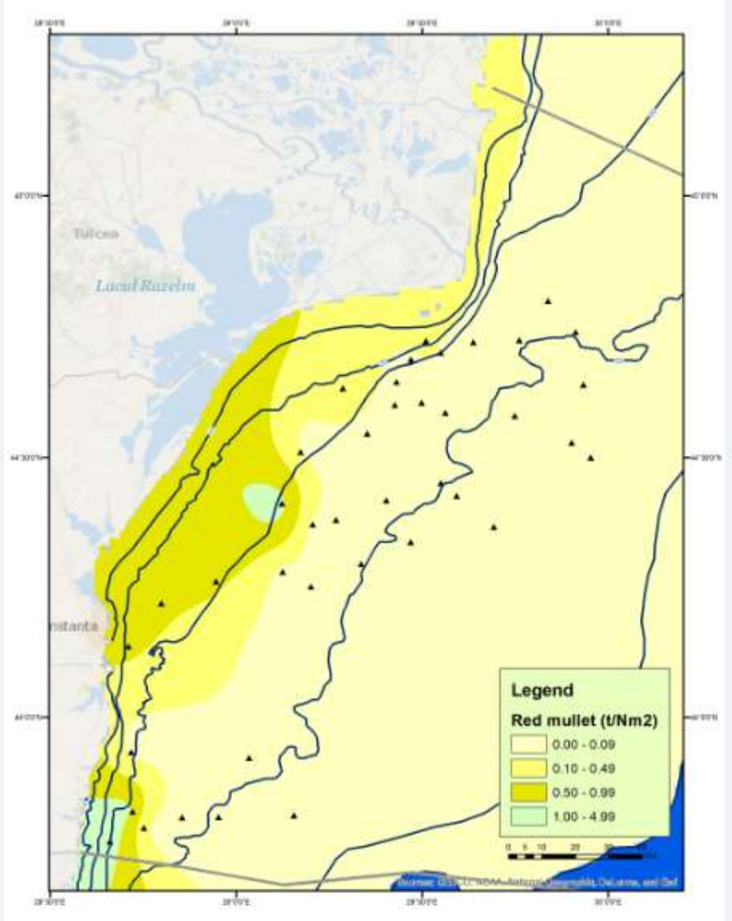


Figure 6.7.3.1.4. Distribution of the red mullet agglomerations at Romanian littoral in Autumn 2013.

Table 6.7.3.1.2. The assessment of red mullet agglomerations in October 2013, demersal trawl survey for Romanian area.

Depth range (m)	**0 - 30m**	**30 – 50m**	**50-70 m**	**Total**
Investigated area (Nm^2)	625	1075	450	2150
Variation of the catches (t/ Nm^2)	0.00-0.570	0.00-1.140	0.00	0.00-1.14
Average catch (t/ Nm^2)	0.285	0.20235	0.00	0.143977
Biomass of the fishing agglomerations (t)	178.125	217.5263	0.00	309.551
Biomass extrapolated the Romanian shelf (t)				719.886

Table 6.7.3.1.3. Tuning data from the Turkish bottom-trawl survey 2009-2012 in thousand numbers per 1 hour of trawling at age

Red Mullet 2012 TUNING DATA

	Age 1	Age 2	Age 3	Age 4	Age 5
2009	672	282	58	13	3
2010	531	261	61	13	1
2011	718	250	40	11	4
2012	387	130	35	16	1
2013	363	171	47	19	1

6.7.4 Assessment of historical parameters

6.7.4.1 Method 1: XSA

6.7.4.2 Justification

The EWG found out that data available in different national databases would allow performing a quantitative assessment of the red mullet stock. The data available for the period 1990 to 2013 of landings, catch at ages 0 - 6+, weights at age in the stock and weights at age, maturity at age and natural mortality were considered appropriate for the application of the XSA. Turkish bottom-trawl survey data were used for tunning.

6.7.4.3 Input parameters

Input data are presented in Table 6.7.4.3.1. Catch at age matrix was constructed based on landing data from all Black Sea countries except Ukraine. As mentioned in the section of Stock Identification (6.7.1.1), fisheries in Ukraine are considered to exploit a different stock than other Black Sea countries. Age composition from the Turkish fisheries (which is accounting for the majority of the catches) was used. Age structured data (2009-2012 ages 1-5) from the Turkish Bottom Trawl Survey were used as a tuning index.

Table 6.7.4.3.1 Input data for XSA of Red mullet in the Black Sea

```
An object of class "FLStock"
Slot "catch":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age   1990    1991    1992    1993    1994    1995    1996    1997    1998
  all 2476.12 2922.44 2250.96  229.04 1293.99 1389.09 2325.28 1241.13 1542.29
    year
age   1999    2000    2001    2002    2003    2004    2005    2006    2007
  all 1946.52 1042.77 1255.66  948.16  719.95  784.36 1246.40 1106.01  881.67
    year
age   2008    2009    2010    2011    2012    2013
  all  837.08 1137.46  778.86  795.83  622.65  750.58

units:  NA NA

Slot "catch.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1990  1991  1992  1993  1994  1995  1996  1997  1998  1999  2000  2001
  0  6555 10900  7299   355  2249  3777  7147  3599  3172  1166   625  1447
  1 21695 23040 27576  1548 13105 12484 16765 10030 24708 52295 28016 28564
  2 22335 31049 23289  2009 12086 10890 17589  9555 17439 30966 16589 17782
  3 16201 20906 15951  1587  8397  8078 13710  7269  8306  8225  4406  5859
  4 13952 14274  9771  1396  7097  8624 15118  7891  6823  2148  1151  2969
  5  1370  1170   734    90   562  1196  1993  1066   917   276   148   394
  6   406   413   232    51   211   189   478   213   175    31    16    66
   year
age 2002  2003  2004  2005  2006  2007  2008  2009  2010  2011  2012  2013
  0  2042  1550  2211  1728  1434  1499  5702 15685  6838 15573  8021  3658
  1 14522 11026 11941 19332 16046 12937 25794 54717 34077 41975 31106 31777
  2 12718  9656  8458 20648 17138 12529 16252 22929 16728 14632 10482 14696
  3  9863  7489  7297 14643 12154  9275  8461  4679  3926  2366  2788  4172
  4  1100   835   719  1810  1502  1091  1154  1098   842   650  1322  1681
  5   280   213   387    82    68   156   180   210    79   225    78    99
  6   309   235   387   165   137   196   167    59     1    90     1     1

units:  NA

Slot "catch.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1990   1991   1992   1993   1994   1995   1996   1997   1998   1999
  0 0.0049 0.0049 0.0049 0.0049 0.0049 0.0049 0.0049 0.0049 0.0058 0.0058
  1 0.0123 0.0123 0.0123 0.0123 0.0123 0.0123 0.0123 0.0123 0.0130 0.0130
```

```
 2 0.0248 0.0248 0.0248 0.0248 0.0248 0.0248 0.0248 0.0248 0.0263 0.0263
 3 0.0399 0.0399 0.0399 0.0399 0.0399 0.0399 0.0399 0.0399 0.0381 0.0381
 4 0.0598 0.0598 0.0598 0.0598 0.0598 0.0598 0.0598 0.0598 0.0516 0.0516
 5 0.0763 0.0763 0.0763 0.0763 0.0763 0.0763 0.0763 0.0763 0.0698 0.0698
 6 0.0935 0.0935 0.0935 0.0935 0.0935 0.0935 0.0935 0.0935 0.0658 0.0658
   year
age 2000   2001   2002   2003   2004   2005   2006   2007   2008   2009
 0 0.0058 0.0058 0.0046 0.0046 0.0062 0.0030 0.0030 0.0046 0.0039 0.0039
 1 0.0130 0.0130 0.0128 0.0128 0.0144 0.0112 0.0113 0.0128 0.0088 0.0088
 2 0.0263 0.0263 0.0231 0.0231 0.0247 0.0215 0.0225 0.0231 0.0178 0.0178
 3 0.0381 0.0381 0.0356 0.0356 0.0389 0.0322 0.0357 0.0356 0.0270 0.0270
 4 0.0516 0.0516 0.0576 0.0576 0.0652 0.0500 0.0572 0.0576 0.0392 0.0392
 5 0.0698 0.0698 0.0727 0.0727 0.0736 0.0719 0.0721 0.0727 0.0579 0.0579
 6 0.0658 0.0658 0.0785 0.0785 0.0790 0.0780 0.0735 0.0785 0.0866 0.0866
   year
age 2010   2011   2012   2013
 0 0.0040 0.0037 0.0040 0.0037
 1 0.0088 0.0088 0.0088 0.0094
 2 0.0183 0.0179 0.0173 0.0174
 3 0.0279 0.0258 0.0274 0.0265
 4 0.0376 0.0390 0.0409 0.0392
 5 0.0535 0.0566 0.0634 0.0615
 6 0.0866 0.0866 0.0866 0.0866

Slot "stock.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
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 1 0.0123 0.0123 0.0123 0.0123 0.0123 0.0123 0.0123 0.0123 0.0130 0.0130
 2 0.0248 0.0248 0.0248 0.0248 0.0248 0.0248 0.0248 0.0248 0.0263 0.0263
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 4 0.0598 0.0598 0.0598 0.0598 0.0598 0.0598 0.0598 0.0598 0.0516 0.0516
 5 0.0763 0.0763 0.0763 0.0763 0.0763 0.0763 0.0763 0.0763 0.0698 0.0698
 6 0.0935 0.0935 0.0935 0.0935 0.0935 0.0935 0.0935 0.0935 0.0658 0.0658
   year
age 2000   2001   2002   2003   2004   2005   2006   2007   2008   2009
 0 0.0058 0.0058 0.0046 0.0046 0.0062 0.0030 0.0030 0.0046 0.0039 0.0039
 1 0.0130 0.0130 0.0128 0.0128 0.0144 0.0112 0.0113 0.0128 0.0088 0.0088
 2 0.0263 0.0263 0.0231 0.0231 0.0247 0.0215 0.0225 0.0231 0.0178 0.0178
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 6 0.0658 0.0658 0.0785 0.0785 0.0790 0.0780 0.0735 0.0785 0.0866 0.0866
   year
age 2010   2011   2012   2013
 0 0.0040 0.0037 0.0040 0.0037
 1 0.0088 0.0088 0.0088 0.0094
 2 0.0183 0.0179 0.0173 0.0174
 3 0.0279 0.0258 0.0274 0.0265
 4 0.0376 0.0390 0.0409 0.0392
 5 0.0535 0.0566 0.0634 0.0615
 6 0.0866 0.0866 0.0866 0.0866

units:  NA

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An object of class "FLQuant"
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 1 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.73
 2 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.73
 3 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.73
 4 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.73
 5 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.73
 6 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.73
   year
age 2005 2006 2007 2008 2009 2010 2011 2012 2013
 0 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.44
 1 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.44
 2 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.44
 3 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.44
 4 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.44
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  3 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  4 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  5 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  6 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
   year
age 2005 2006 2007 2008 2009 2010 2011 2012 2013
  0 0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
  1 0.6  0.6  0.6  0.6  0.6  0.6  0.6  0.6  0.6
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  3 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  4 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  5 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  6 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
```

6.7.4.4 Results

Parameters and options in applying XSA on the Red mullet are shown in Table 6.7.4.4.1. Final estimates were made with applying shrinkage to the mean F of the final 5 years. Retrospective analyses (Figure 6.7.4.4.1.) have not shown any pervasive patterns. Residuals between observed and estimated log catchabilities of the tunning index were relatively small and no systematic patterns were detected (Figure 6.7.4.4.2).

Table 6.7.4.4.1 Parameters and options for XSA of Red mullet in the Black Sea

```
FLXSA.control.mul2 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2,
rage=0, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=5,shk.ages=3,window=100, tsrange=20, tspower=3,
vpa=FALSE)
```

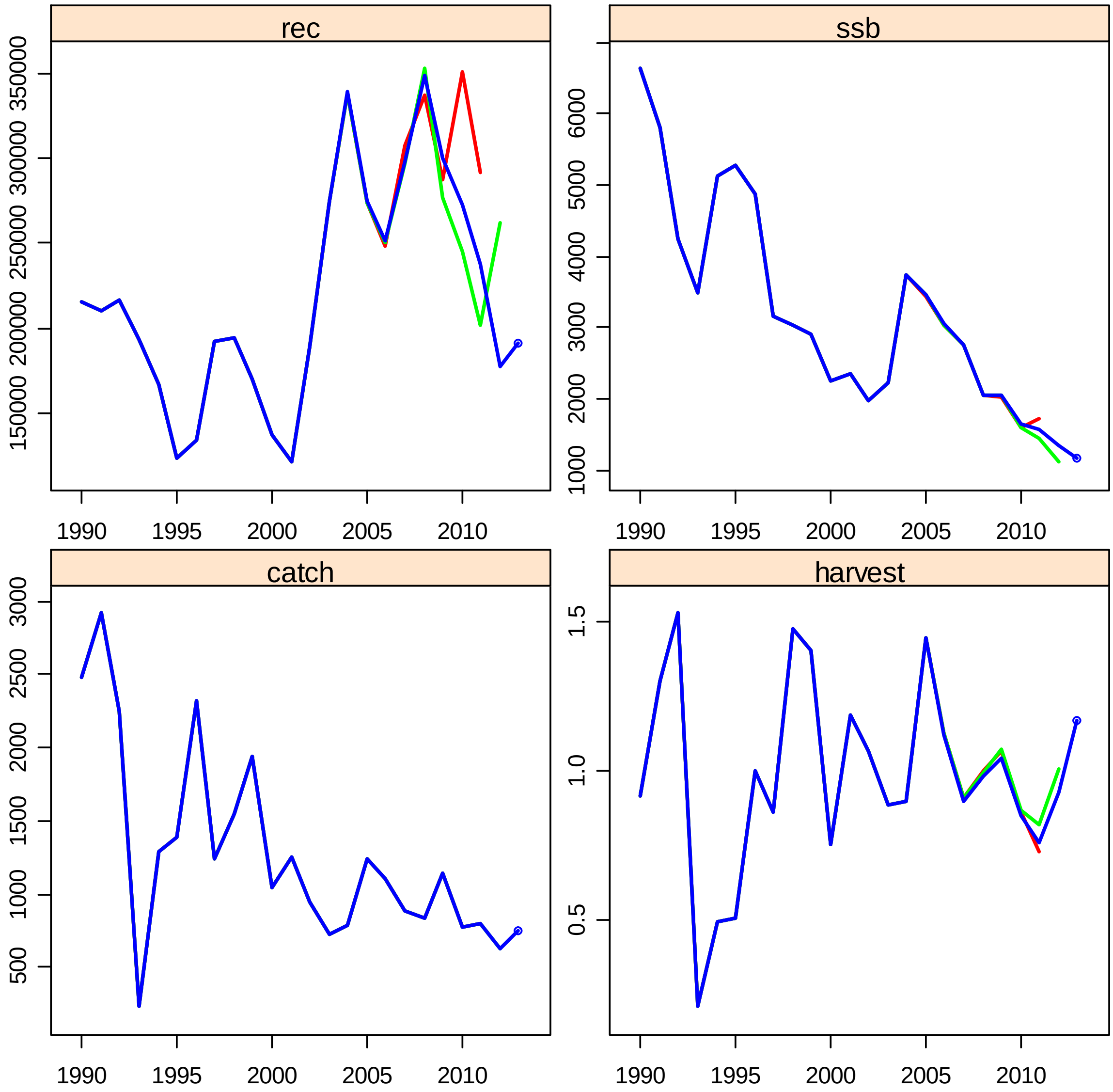


Figure 6.7.4.4.1. Retrospective analyses of Red mullet in the Black Sea

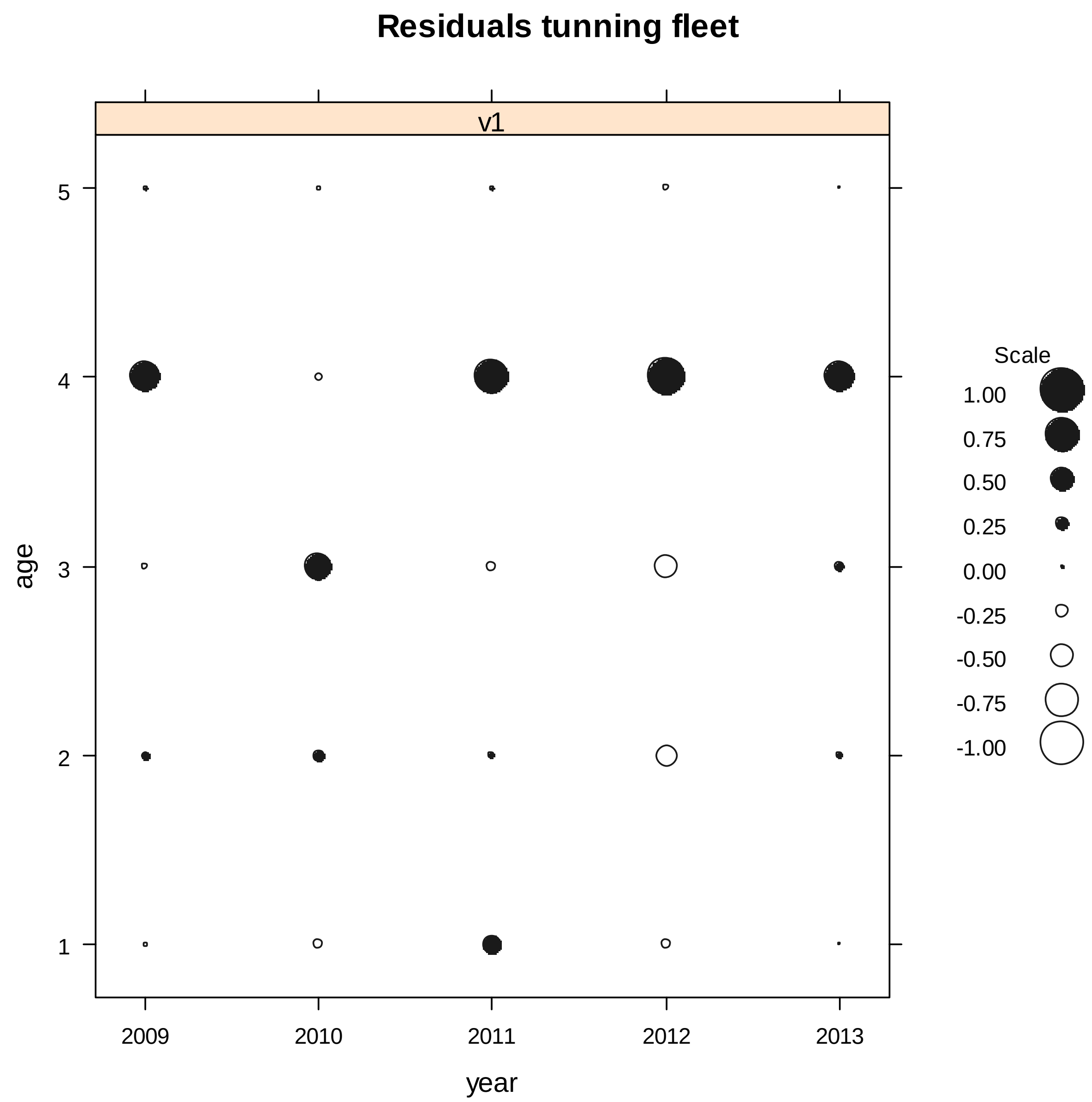


Figure 6.7.4.4.2 Residuals between observed and estimated log catchabilities of the tunning index in Red mullet

Table 6.7.4.4.2 Diagnostics of the XSA on Red mullet in the Black Sea

```
An object of class "FLXSA"
Slot "survivors":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1990       1991       1992       1993       1994       1995
  0 215264.791 209735.436 216088.656 192864.195 167196.766 123263.467
  1 151943.449 133377.855 126329.805 133311.380 123926.671 105875.942
  2  99878.189  80446.470  67410.163  59230.737  84615.085  69296.281
  3  50593.125  46400.934  26893.051  24724.740  36534.492  44795.954
  4  20464.450  19582.208  13106.433   4519.127  14650.036  16790.793
  5   2811.623   1983.109   1156.502    599.609   1790.166   3739.681
  6    799.446    711.337    338.247    155.781    313.944    701.916
   year
age 1996       1997       1998       1999       2000       2001
  0 133715.097 192129.411 194305.277 169436.141 137036.130 120804.409
  1  76355.049  80381.791 120850.073 122594.085 108187.309  87754.685
  2  58169.318  35721.205  43719.537  58003.214  36987.335  47193.201
  3  35889.899  23347.656  15337.690  14161.849  12505.385  10508.207
  4  22367.479  12111.869   9203.232   3212.310   2520.029   4518.026
  5   3892.960   2272.992   1467.809    451.631    345.034    699.292
  6   1448.678    907.788    608.405    209.413     69.371    103.442
   year
age 2002       2003       2004       2005       2006       2007
  0 189227.807 275040.940 339369.196 274247.803 251573.790 297426.343
  1  76641.194 120230.856 175892.478 162010.198 130962.910 120240.193
  2  33594.066  37705.543  68584.478  76474.764  64653.961  51973.124
  3  16123.751  11429.368  16534.621  27179.961  22520.104  19260.183
  4   2065.710   2469.040   1350.866   2902.630   2933.146   2415.375
  5    527.095    447.622    920.048    151.867    142.307    370.826
  6    134.177    114.763    117.348    174.725     16.262     21.374
   year
age 2008       2009       2010       2011       2012       2013
  0 348749.791 300103.801 272185.695 237437.170 176870.910 190583.269
  1 142291.828 164107.350 133734.245 126421.817 103612.383  79667.530
  2  48964.008  50665.603  41100.449  40791.596  31784.906  28338.058
  3  16348.726  12314.112   8498.974   8194.154   9500.351   8040.862
  4   2842.981   2005.000   2686.135   1370.316   2306.367   2642.884
  5    406.622    568.955    204.000    709.959    209.140    193.731
  6     70.409     70.997    128.389     43.462    185.919     46.632
   year
age 2014
  0   6456.293
  1 119805.616
  2  25806.004
  3   6456.293
  4   1830.267
  5    352.765
  6     45.310

units:  NA

Slot "se.int":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2014
  0 2.00000
  1 0.29885
  2 0.23280
  3 0.22717
  4 0.32907
  5 0.27725

units:  NA

Slot "se.ext":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2014
  0 0.00000
  1     Inf
  2 0.15565
  3 0.18854
  4 0.22809
  5 0.10299
```

```
units:  NA

Slot "n.fshk":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1
  all NA

units:  NA

Slot "n.nshk":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1
  all NA

units:  NA

Slot "var.fshk":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1
  all NA

units:  NA

Slot "var.nshk":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1
  all NA

units:  NA

Slot "q.hat":
$ NA
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1
  1 0.0077097
  2 0.0109027
  3 0.0097914
  4 0.0097914
  5 0.0097914

units:  NA


Slot "q2.hat":
$ NA
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1
  1 1
  2 1
  3 1
  4 1
  5 1

units:  NA


Slot "diagnostics":
           w      nhat yrcls age year source
1   0.25000000  6.567146  1985   5 1990   fshk
2   0.25000000  5.823778  1986   5 1991   fshk
3   0.25000000  5.048448  1987   5 1992   fshk
4   0.25000000  5.749213  1988   5 1993   fshk
5   0.25000000  6.553814  1989   5 1994   fshk
6   0.25000000  7.278407  1990   5 1995   fshk
7   0.25000000  6.811011  1991   5 1996   fshk
8   0.25000000  6.410840  1992   5 1997   fshk
```

```
9  0.25000000  5.344308  1993   5 1998   fshk
10  0.25000000  4.239476  1994   5 1999   fshk
11  0.25000000  4.639008  1995   5 2000   fshk
12  0.25000000  4.899159  1996   5 2001   fshk
13  0.25000000  4.742869  1997   5 2002   fshk
14  0.25000000  4.765147  1998   5 2003   fshk
15  0.25000000  5.163216  1999   5 2004   fshk
16  0.25000000  2.788828  2000   5 2005   fshk
17  0.25000000  3.062161  2001   5 2006   fshk
18  0.25000000  4.254315  2002   5 2007   fshk
19  0.25000000  4.262640  2003   5 2008   fshk
20  5.07955675  4.889869  2004   5 2009 TUR BT
21  0.25000000  4.147936  2004   5 2009   fshk
22  4.86323692  3.755517  2005   5 2010 TUR BT
23  0.22387904  4.293616  2005   4 2009 TUR BT
24  0.25000000  3.623169  2005   5 2010   fshk
25  6.02048820  5.268958  2006   5 2011 TUR BT
26  0.72488526  5.113386  2006   4 2010 TUR BT
27  1.03841154  5.160149  2006   3 2009 TUR BT
28  0.25000000  4.769390  2006   5 2011   fshk
29  5.13975336  3.783852  2007   5 2012 TUR BT
30  0.35896395  4.440562  2007   4 2011 TUR BT
31  0.38268350  4.309216  2007   3 2010 TUR BT
32  0.18512650  3.933295  2007   2 2009 TUR BT
33  0.25000000  3.402432  2007   5 2012   fshk
34  4.03592511  3.813465  2008   5 2013 TUR BT
35  0.15548360  4.463945  2008   4 2012 TUR BT
36  0.29067259  3.685503  2008   3 2011 TUR BT
37  0.16826601  3.973457  2008   2 2010 TUR BT
38  0.08623619  3.794640  2008   1 2009 TUR BT
39  0.25000000  3.457886  2008   5 2013   fshk
40  0.50961237  6.400759  2009   4 2013 TUR BT
41  0.94373793  5.461641  2009   3 2012 TUR BT
42  0.64108494  5.932289  2009   2 2011 TUR BT
43  0.40288164  5.738741  2009   1 2010 TUR BT
44  0.25000000  6.335287  2009   4 2013   fshk
45  2.78684774  7.646780  2010   3 2013 TUR BT
46  2.06095230  7.141597  2010   2 2012 TUR BT
47  1.07241072  7.818828  2010   1 2011 TUR BT
48  0.25000000  7.752273  2010   3 2013   fshk
49  3.93099709  8.831341  2011   2 2013 TUR BT
50  2.23014572  8.627344  2011   1 2012 TUR BT
51  0.25000000  9.150122  2011   2 2013   fshk
52  5.58863538 10.143680  2012   1 2013 TUR BT
53  0.25000000 10.486577  2012   1 2013   fshk
54  0.25000000 10.738003  2013   0 2013   fshk
55 15.51251659 11.709027  2013   0 2013   nshk

Slot "control":
tol            6.863279e-07
maxit          30
min.nse        0.3
fse            2
rage           0
qage           3
shk.n          TRUE
shk.f          TRUE
shk.yrs        5
shk.ages       3
window         100
tsrange        20
tspower        3
vpa            FALSE

Slot "catch.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
age   1
  all NA

units:  NA
```

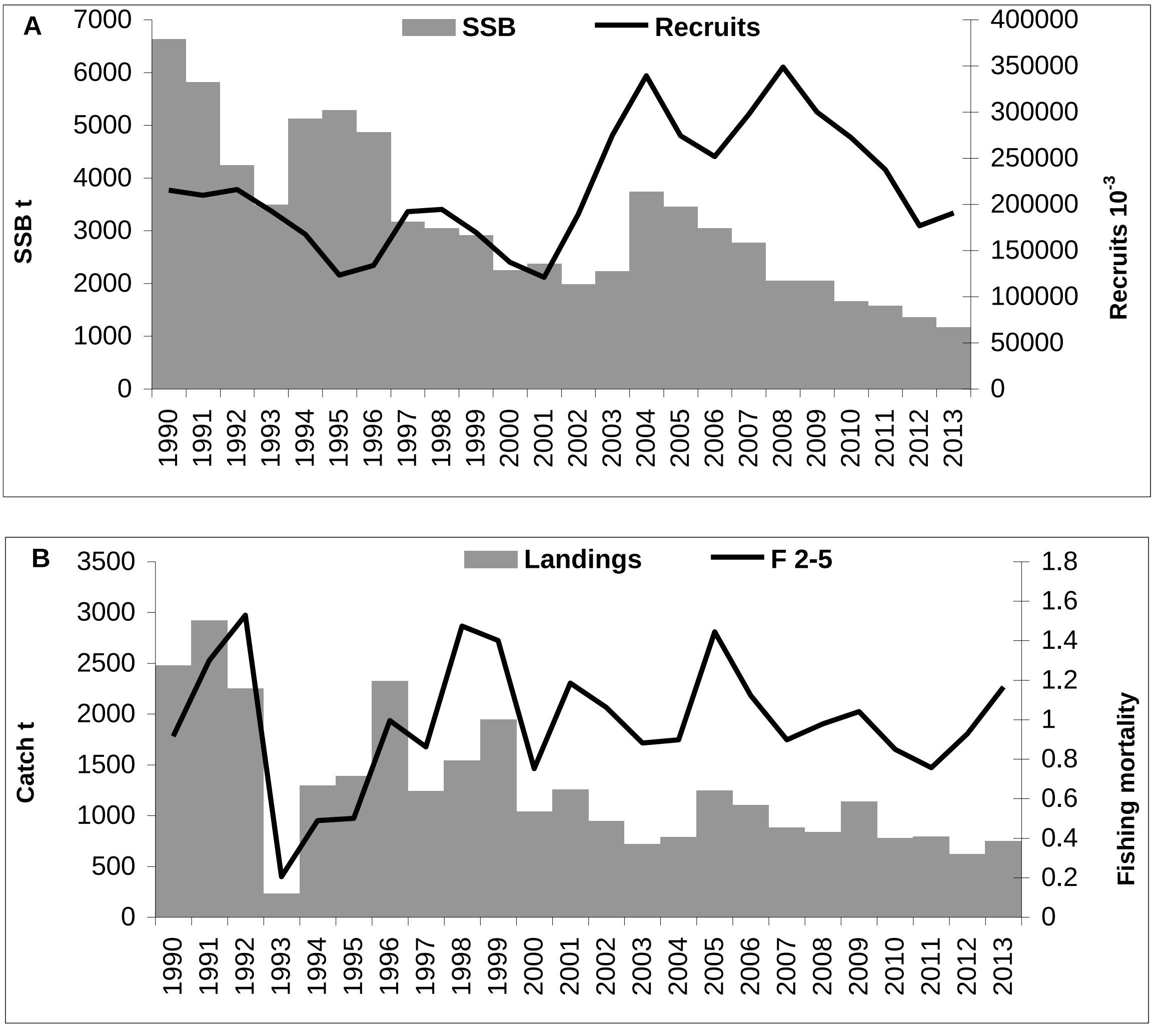


Figure 6.7.4.4.3. Summary of the population estimates from the XSA

The summary of the population estimates from the XSA is presented in Fig 6.7.4.4.3. The SSB follows a consistent downward trend with periodic increases due to good recruitment (in 1994-1996 and 2004-2007). Estimates of recruitment are rather imprecise due to the lack of survey data. The present recruitment is assessed at a medium level, following a period of peak recruitment in 2004-2008. Fishing mortality is consistently high: 0.8 - 1.4 except in 1993 when the catch dropped suddenly about 10 time compared to the previous years.

Detailed assessment results are presented in the Table 6.7.4.4.3 below.

Table 6.7.4.4.3 XSA results of Red mullet in the Black Sea.

```
Slot "stock.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1990       1991       1992       1993       1994       1995
  0 2.1526e+05 2.0974e+05 2.1609e+05 1.9286e+05 1.6720e+05 1.2326e+05
  1 1.5194e+05 1.3338e+05 1.2633e+05 1.3331e+05 1.2393e+05 1.0588e+05
  2 9.9878e+04 8.0446e+04 6.7410e+04 5.9231e+04 8.4615e+04 6.9296e+04
  3 5.0593e+04 4.6401e+04 2.6893e+04 2.4725e+04 3.6534e+04 4.4796e+04
  4 2.0464e+04 1.9582e+04 1.3106e+04 4.5191e+03 1.4650e+04 1.6791e+04
  5 2.8116e+03 1.9831e+03 1.1565e+03 5.9961e+02 1.7902e+03 3.7397e+03
  6 7.9945e+02 6.6283e+02 3.4351e+02 3.3452e+02 6.5485e+02 5.7554e+02
```

```
   year
age 1996       1997       1998       1999       2000       2001
  0 1.3372e+05 1.9213e+05 1.9431e+05 1.6944e+05 1.3704e+05 1.2080e+05
  1 7.6355e+04 8.0382e+04 1.2085e+05 1.2259e+05 1.0819e+05 8.7755e+04
  2 5.8169e+04 3.5721e+04 4.3720e+04 5.8003e+04 3.6987e+04 4.7193e+04
  3 3.5890e+04 2.3348e+04 1.5338e+04 1.4162e+04 1.2505e+04 1.0508e+04
  4 2.2367e+04 1.2112e+04 9.2032e+03 3.2123e+03 2.5200e+03 4.5180e+03
  5 3.8930e+03 2.2730e+03 1.4678e+03 4.5163e+02 3.4503e+02 6.9929e+02
  6 8.9334e+02 4.3661e+02 2.6371e+02 4.7869e+01 3.6000e+01 1.1135e+02
   year
age 2002       2003       2004       2005       2006       2007
  0 1.8923e+05 2.7504e+05 3.3937e+05 2.7425e+05 2.5157e+05 2.9743e+05
  1 7.6641e+04 1.2023e+05 1.7589e+05 1.6201e+05 1.3096e+05 1.2024e+05
  2 3.3594e+04 3.7706e+04 6.8584e+04 7.6475e+04 6.4654e+04 5.1973e+04
  3 1.6124e+04 1.1429e+04 1.6535e+04 2.7180e+04 2.2520e+04 1.9260e+04
  4 2.0657e+03 2.4690e+03 1.3509e+03 2.9026e+03 2.9331e+03 2.4154e+03
  5 5.2709e+02 4.4762e+02 9.2005e+02 1.5187e+02 1.4231e+02 3.7083e+02
  6 5.5526e+02 4.7441e+02 8.5222e+02 2.7447e+02 2.6216e+02 4.3156e+02
   year
age 2008       2009       2010       2011       2012       2013
  0 3.4875e+05 3.0010e+05 2.7219e+05 2.3744e+05 1.7687e+05 1.9058e+05
  1 1.4229e+05 1.6411e+05 1.3373e+05 1.2642e+05 1.0361e+05 7.9668e+04
  2 4.8964e+04 5.0666e+04 4.1100e+04 4.0792e+04 3.1785e+04 2.8338e+04
  3 1.6349e+04 1.2314e+04 8.4990e+03 8.1942e+03 9.5004e+03 8.0409e+03
  4 2.8430e+03 2.0050e+03 2.6861e+03 1.3703e+03 2.3064e+03 2.6429e+03
  5 4.0662e+02 5.6896e+02 2.0400e+02 7.0996e+02 2.0914e+02 1.9373e+02
  6 3.4781e+02 1.4952e+02 2.4075e+00 2.6791e+02 2.5063e+00 1.8725e+00

units:  NA

Slot "harvest":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1990      1991      1992      1993      1994      1995      1996
  0 0.0386827 0.0669509 0.0430012 0.0022963 0.0169033 0.0389299 0.0689237
  1 0.1959164 0.2423903 0.3174554 0.0145750 0.1412988 0.1589100 0.3196497
  2 0.3266317 0.6557241 0.5629914 0.0431838 0.1959947 0.2179353 0.4728614
  3 0.5091943 0.8242164 1.3435491 0.0833616 0.3374261 0.2545097 0.6462700
  4 1.8940235 2.3892215 2.6445801 0.4860105 0.9254425 1.0216609 1.8465110
  5 0.9343712 1.3286435 1.5647067 0.2070651 0.4962492 0.5083488 1.0159141
  6 0.9343712 1.3286435 1.5647067 0.2070651 0.4962492 0.5083488 1.0159141
   year
age 1997      1998      1999      2000      2001      2002      2003
  0 0.0236184 0.0205517 0.0086120 0.0056994 0.0150381 0.0135379 0.0070471
  1 0.1689926 0.2940523 0.7583032 0.3896142 0.5201958 0.2693276 0.1213475
  2 0.4054313 0.6872434 1.0943390 0.8184190 0.6339564 0.6381633 0.3843507
  3 0.4909419 1.1233230 1.2862811 0.5780843 1.1866824 1.4364640 1.6954403
  4 1.6704149 2.5744450 1.7911025 0.8419580 1.7084499 1.0892803 0.5471584
  5 0.8780122 1.5072185 1.4333892 0.7646350 1.2109090 1.0845112 0.8988022
  6 0.8780122 1.5072185 1.4333892 0.7646350 1.2109090 1.0845112 0.8988022
   year
age 2004      2005      2006      2007      2008      2009      2010
  0 0.0094293 0.0091179 0.0082450 0.0072865 0.0238339 0.0782738 0.0368605
  1 0.1029121 0.1886099 0.1941874 0.1684059 0.3026328 0.6545017 0.4573785
  2 0.1955863 0.4925524 0.4810095 0.4265768 0.6503396 1.0553017 0.8825980
  3 1.0098393 1.4964044 1.5025541 1.1831866 1.3685058 0.7926425 1.0949041
  4 1.4554955 2.2853830 1.3380976 1.0517253 0.8788066 1.5552810 0.6006514
  5 0.9312101 1.5041754 1.1658219 0.9314013 1.0152120 0.7586251 0.8160992
  6 0.9312101 1.5041754 1.1658219 0.9314013 1.0152120 0.7586251 0.8160992
   year
age 2011      2012      2013
  0 0.0992462 0.0675580 0.0242075
  1 0.6506326 0.5664512 0.6872105
  2 0.7271473 0.6444552 1.0390525
  3 0.5377473 0.5494579 1.0399473
  4 1.1497937 1.7469573 1.5729323
  5 0.6097758 0.7705655 1.0127101
  6 0.6097758 0.7705655 1.0127101

units:  f

Slot "index.name":
[1] "TUR BT"

Slot "index.range":
[[1]]
      min       max plusgroup   minyear   maxyear    startf      endf
        1         5         5      2009      2013         0         1


Slot "index":
$ NA
```

```
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2009      2010      2011      2012      2013
  1 1241.2559  907.2172 1324.2318  690.6085  605.2344
  2  604.9299  525.6954  474.8881  239.1884  327.5518
  3  112.9520  132.7176   70.5740   62.0397   90.0596
  4   33.0738   23.5131   24.4020   43.2656   44.1431
  5    5.7675    1.9647    7.2607    1.9312    1.8963

units:  NA


Slot "index.res":
$ NA
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2009        2010        2011        2012        2013
  1 -0.01912214 -0.12795300  0.30648342 -0.14556410 -0.01472666
  2  0.09085740  0.15969498  0.06559519 -0.37074784  0.05843248
  3 -0.06528230  0.46677869 -0.12825878 -0.40505317  0.13443522
  4  0.52159644 -0.11204526  0.59812424  0.65018352  0.53406538
  5  0.03469258 -0.01650206  0.04352701 -0.05858516 -0.00029634

units:  NA


Slot "index.hat":
$ NA
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2009      2010      2011      2012      2013
  1 162245.13 118582.78 173090.95  90269.75  79110.46
  2  56092.79  48745.69  44034.52  22179.01  30372.60
  3  11649.40  13687.95   7278.71   6398.52   9288.37
  4   3411.09   2425.04   2516.72   4462.23   4552.73
  5    594.84    202.64    748.84    199.18    195.58

units:  NA


Slot "index.var":
$ NA
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 2009      2010      2011      2012      2013
  1 0.0405250 0.0405250 0.0405250 0.0405250 0.0405250
  2 0.0552866 0.0552866 0.0552866 0.0552866 0.0552866
  3 0.1293445 0.1293445 0.1293445 0.1293445 0.1293445
  4 0.4150963 0.4150963 0.4150963 0.4150963 0.4150963
  5 0.0020915 0.0020915 0.0020915 0.0020915 0.0020915

units:  NA


Slot "call":
[1] ".local"  "stock"   "indices" "..1"

Slot "name":
character(0)

Slot "desc":
character(0)

Slot "range":
      min       max plusgroup   minyear   maxyear   minfbar   maxfbar
        0         6         6      1990      2013         2         5


Summary
       ssb      fbar      rec    catch landings
1  6634.641 0.9160552 215264.8 2476.1175     2476
2  5816.085 1.2994514 209735.4 2922.4383     2922
3  4246.888 1.5289569 216088.7 2250.9640     2251
4  3492.764 0.2049052 192864.2  229.0407      229
5  5124.958 0.4887781 167196.8 1293.9944     1294
6  5286.801 0.5006137 123263.5 1389.0862     1389
```

7	4867.722	0.9953891	133715.1	2325.2813	2325
8	3172.040	0.8612001	192129.4	1241.1343	1241
9	3041.548	1.4730575	194305.3	1542.2943	1542
10	2916.617	1.4012779	169436.1	1946.5175	1945
11	2255.015	0.7507741	137036.1	1042.7671	1042
12	2367.061	1.1849994	120804.4	1255.6635	1255
13	1984.321	1.0621047	189227.8	948.1559	947
14	2239.057	0.8814379	275040.9	719.9534	719
15	3741.255	0.8980328	339369.2	784.3595	784
16	3456.728	1.4446288	274247.8	1246.4048	1245
17	3052.973	1.1218708	251573.8	1106.0113	1106
18	2769.533	0.8982225	297426.3	881.6677	881
19	2055.073	0.9782160	348749.8	837.0786	838
20	2044.933	1.0404626	300103.8	1137.4603	1139
21	1657.070	0.8485632	272185.7	778.8597	780
22	1579.879	0.7561160	237437.2	795.8347	795
23	1355.093	0.9278590	176870.9	622.6482	623
24	1172.551	1.1661605	190583.3	750.5771	754

6.7.5 Short term prediction of stock biomass and catch

6.7.5.1 Justification

A deterministic short term prediction of stock size and catch was conducted based on XSA results.

6.7.5.2 Input parameters

The input parameters are listed in the Table below. They do represent short term averages of the XSA inputs. The exploitation pattern used is the 2013 estimated vector rescaled to the average exploitation patterns estimated for the years 2011-2013. Due to the lack of recruitment index. recruitment was estimated using the geometric mean from 2010-2012.

As the fishery for red mullet in the Black Sea is not constrained by an international TAC, the year 2013 was defined as a *status quo* effort year with unchanged fishing mortality.

Table 6.7.5.2.1. Red Mullet in the Black Sea. Input to short term prediction.

2014						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	225265	0.7300	0.0000	0.0037	0.0782	0.0037
1	100396	0.7300	0.6000	0.0094	0.7792	0.0094
2	25553	0.7300	0.8000	0.0174	0.9863	0.0174
3	4857	0.7300	1.0000	0.0265	0.8703	0.0265
4	1261	0.7300	1.0000	0.0392	1.8288	0.0392
5	226	0.7300	1.0000	0.0615	0.9791	0.0615
6	40	0.7300	1.0000	0.0866	0.9791	0.0866
2015						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	225265	0.7300	0.0000	0.0037	0.0782	0.0037
1		0.7300	0.6000	0.0094	0.7792	0.0094
2		0.7300	0.8000	0.0174	0.9863	0.0174
3		0.7300	1.0000	0.0265	0.8703	0.0265
4		0.7300	1.0000	0.0392	1.8288	0.0392
5		0.7300	1.0000	0.0615	0.9791	0.0615
6		0.7300	1.0000	0.0866	0.9791	0.0866
2016						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	225265	0.7300	0.0000	0.0037	0.0782	0.0037
1		0.7300	0.6000	0.0094	0.7792	0.0094
2		0.7300	0.8000	0.0174	0.9863	0.0174
3		0.7300	1.0000	0.0265	0.8703	0.0265
4		0.7300	1.0000	0.0392	1.8288	0.0392
5		0.7300	1.0000	0.0615	0.9791	0.0615
6		0.7300	1.0000	0.0866	0.9791	0.0866

6.7.5.3 Results

The *status quo* fishing in 2014 would result in landings of 733 t and SSB of 1117 t. The forecast for 2015 and 2016 marks a decrease in SSB to 1045 t and 1024 t respectively. Catches are expected to decrease to 690 t in 2015, and 680 t in 2016.

Estimates of recruitment are rather imprecise due to the lack of survey data. The present level of recruitment equal to 225 265 was estimated as the geometric mean over 2010-2012. It is assessed as being at medium level, following a period of peak recruitment in 2004-2008.

Total catches have been gradually decreasing since 1996 under a consistently high fishing pressure due mainly to the Turkish fishery. Under the status quo F assumption, catches are expected to remain low (around 700 t) in 2014 - 2016.

More management options through multiplications of the fishing mortality are given in Table 6.7.5.3.1. If sustainable fishing is carried out at Fmsy level of 0.46 ($F_{0.1}$ as a F_{msy} proxy) the SSB would recover to 1360 t. The cost of this option would be a decrease in catch to 331 t in 2015, but the catch is expected to rise to 419 in the 2016.

The continuous drop in SSB and catches over the last years due to the consistently high fishing pressure, makes the EWG to believe that exploitation should be reduced below the level of F_{msy} - 0.46.

Table 6.7.5.3.1. Red Mullet in the Black Sea. Single option (status quo) short term prediction.

2014	F-factor:	1	reference F2-5	1.1662			1 January
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0782	12076	45	225264.8386	833	0	0
1	0.7792	40373	380	100396.0119	944	60238	566
2	0.9863	12046	210	25553.336	445	20443	356
3	0.8703	2108	56	4857.172784	129	4857	129
4	1.8288	831	33	1260.812447	49	1261	49
5	0.9791	106	7	226.3072596	14	226	14
6	0.9791	19	2	39.64368173	3	40	3
		67559	733	357598	2417	87065	1117
2015	F-factor:	1	reference F2-5	1.1662			1 January
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0782	12076	45	225265	833	0	0
1	0.7792	40373	380	100396	944	60238	566
2	0.9863	10464	182	22197	386	17758	309
3	0.8703	1994	53	4593	122	4593	122
4	1.8288	646	25	980	38	980	38
5	0.9791	46	3	98	6	98	6
6	0.9791	19	2	41	4	41	4
		65618	690	353570	2333	83708	1045
2016	F-factor:	1	reference F2-5	1.1662			1 January
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0782	12076	45	225265	833	0	0
1	0.7792	40373	380	100396	944	60238	566
2	0.9863	10464	182	22197	386	17758	309
3	0.8703	1732	46	3989	106	3989	106
4	1.8288	611	24	927	36	927	36
5	0.9791	36	2	76	5	76	5
6	0.9791	8	1	18	2	18	2
		65300	680	352868	2312	83006	1024

Table 6.7.5.3.2. Red Mullet in the Black Sea. Management option table providing short term prediction.

2014					2015					2016		
F-factor	reference F	stock biomas	sp. stock biom	catch in weigl	F-factor	reference F	stock biomas	sp. stock biom	catch in weigl	stock biomas	sp. stock biom	catch
1.0000	1.1662	2417	1117	733	0.0000	0.0000	2333	1045	0	3098	1688	0
					0.1000	0.1166	2333	1045	93	2989	1595	138
					0.2000	0.2332	2333	1045	181	2887	1508	252
					0.3000	0.3498	2333	1045	261	2794	1429	347
					0.4000	0.4665	2333	1045	335	2707	1355	424
					0.5500	0.6414	2333	1045	438	2591	1258	517
					0.6000	0.6997	2333	1045	469	2554	1226	542
					0.7000	0.8163	2333	1045	530	2486	1169	588
					0.8000	0.9329	2333	1045	586	2424	1117	624
					0.9000	1.0495	2333	1045	640	2367	1070	654
				Fsq	**1.0000**	**1.1662**	**2333**	**1045**	**690**	**2312**	**1024**	**680**
					1.1000	1.2828	2333	1045	734	2260	982	700
					1.2000	1.3994	2333	1045	778	2214	943	717
					1.3000	1.5160	2333	1045	817	2172	909	730
					1.4000	1.6326	2333	1045	857	2131	875	743
					1.5000	1.7492	2333	1045	893	2095	846	753
				Fmsy	**0.394**	**0.460**	**2333**	**1045**	**331**	**2712**	**1360**	**419**

6.7.6 Medium term prediction of stock biomass and catch

The current state of the assessment does not allow any reliable formulation of a medium term prediction of stock size and biomass under various management scenarios

6.7.7 Long term predictions

YRR analyses were performed by Sampson et al. (2013). The EWG endorsed $F_{0.1}$=0.46, as a Fmsy proxy, as recommended by Sampson et al. (2013).

6.7.8 Scientific advice

The lack of a fishery independent scientific survey to monitor red mullet all over the Black Sea to indicate trends in total mortality and recruitment appears the major data deficiency in the assessment. The EWG 14- 14 recommends such survey to be established.

6.7.8.1 Short term considerations

State of the spawning stock size:

The EWG has accepted the XSA assessment, considers both catch at age and survey data as rather meagre and needing a better quality data in future. The Turkish sampling project is over in 2014, that will make problematic further assessments of this stock. The SSB follows a consistent downward trend with periodic increases due to good recruitment (in 1994-1996 and 2004-2007). During the 1990s the SSB of the range of 5000 - 6000 t in the recent years it has dropped to about 1500-2000t. SSB in 2013 is estimated at 1173 t.

State of recruitment:

Estimates of recruitment are rather imprecise due to the lack of survey data. The present level of recruitment, estimated as a geometric mean over 2010-2012, is assessed as average, following a period of peak recruitment in 2004-2008.

State of exploitation:

Total catches have been gradually decreasing since 1996 under a consistently high fishing pressure due mainly to the Turkish fishery. Fishing mortality has been assessed as consistently high F= 0.8 - 1.4 since 1990, that is about 2-3 times of the F_{msy}=0.46.

Under the status quo F assumption, catches are expected to remain low 733 - 680 t in 2014 - 2016, respectively. Under Fmsy fishing catches should drop to 331-419 t, that would bring some increase in SSB to 1360 t.

At the present level of exploitation the average recruitment in the last years cannot contribute to SSB recovery.

The EWG suggests that the exploitation should be kept below the level of Fmsy.

6.7.8.2 Medium term considerations

EWG 14-14 suggest that exploitation should be kept below the F_{msy} reference level in order to enable the rebuilding of the stock.

6.8 ATLANTIC BONITO IN GSA 29

6.8.1 Biological features

Atlantic bonito (*Sarda sarda* Bloch, 1793), which is a member of Scombridae, exhibiting wide distribution in temperate and tropical coastal areas, coasts of the Atlantic Ocean, the Mediterranean, and the Black Sea (Collette and Chao,1975; Collette and Nauen, 1983; Sabatés and Recasens, 2001; Yoshida, 1980). It is an oceanodromous species which lives in schools along the neritic area and may enter in estuaries. It can be found from 80 to 200 meters depth (Collette and Nauen, 1983). Temperature is one of the most important environmental factors determining the distribution of tuna fish. This species can adapt to different temperatures 12°C to 27°C and salinities 14 to 39‰.

Atlantic bonito plays a major role as top predator in the Black Sea ecosystem and has high commercial importance, especially for the Turkish fishery since 1950 (Prodanov et al., 1997; Cengiz, 2013; FAO, 2014). While total catches of Atlantic bonito from all Black Sea coastal states reached the maximum of 20,000 tons in 1969, thereafter no Atlantic bonito catches have beem recorded from anycountry, other than Turkey and Bulgaria. This was mainly due to pollution in northwest Black Sea, problems with migration routes (Changing of oceanographic conditions) and heavy fishing impact on Atlantic bonito stocks (Daskalov, 2002; Eremeev and Zuyev, 2007).

Reports of last 25 years have shown that a dominant part of the Atlantic bonito catches in the Black Sea, are obtained in Turkish waters (TUIK, 2013). However, when considering the long-term statistics, Turkey's bonito catch from the Black Sea was also subjected to important fluctuations.There has been a decrease in catches since 2002. In 2005 an exceptional catch was landed - 70 797 t. In 2006, the catch decreased to 29 690 t. The 2005 catch was the highest in the last 35 years. It may be caused by some oceanographic factors and climate changes observed in the early 2000s such as:

- Egg hatching pre larva, post larva and juvenile periods tend to increase, causing a decrease in natural mortality rate. The favorable water temperature and alterations in pelagic food web hada positive effect on bonito population.
- The spawning period may be prolonged compared to the period before 2000.
- Migrating population into Black Sea spend more time than before and feed on abundant small pelagic species as anchovy, horse mackerel and sprat.

Feeding, Spawning and Wintering Migration

Atlantic bonito enter the Black Sea for reproduction and feeding migrating in spring from the Aegean Sea to the Sea of Marmara and to the Black Sea. In the early of autumn, it is regularly caught in the coastal areas of Black Sea and Marmara Sea especially by the Turkish fisheries. The migration back to the Marmara and Aegean Seas starts in late autumn (Prodanov et all., 1997).

Studies and statistics provide evidence that while a stock of bonito was migrating, a small part of bonito remained in the Black Sea (Nümann, 1954). Bonito migration in the Black Sea is mainly governed by biological and oceanographic conditions (Demir, 1961).

Demir (1957) reported that spawning period of Atlantic bonito extends from May to August, with most spawning occurring in June and July and in the most northern parts of the Black Sea. Gonad histology reported by Kahraman *et all.,* (2014) show that ovaries from immature fish showing only perinucleolar stage oocytes are to be found more frequently in the winter period between September and May. In contrast the existence of vitellogenic oocytes, mostly observed between May and September,confirms that the reproductive activity of Atlantic bonito occurrs primarily during the summer months. The spawning specimens with postovulatory follicles are first observed in June and July. The average GSI values increase starts in May and peaks in June and July, thus leading to the conclusion that these specimens reaches complete sexual maturity in June and July (Kahraman *et all.,* 2014). It was reported that the optimum water temperature for spawning is 18.0ºC (between 13.9-23.1 ºC) (Majorova and Tkacheva, 1960).

6.8.1.1 Stock identification

N/A

6.8.1.2 Growth

Age determination and growth of Atlantic bonito have been studied by means of different methodologies: otholiths, vertebrae, spines and size frequency. The species is fast growing and the age range of bonito is found between 0-3 years by size frequency for the 2000-2013 period, in the Black Sea. A total of 477 individuals were studied in 2013 years from market sampling, purse seine and gill nets off the Turkish coast of Black Sea (from the border of Bulgaria to the border of Georgia). The von Bertlanffy Growth Parameters (VBGF) is given for Black Sea in Table 6.8.1.2.1 and for other seas in Table 6.8.2.2 (Genç et all., 2014).

The length–weight relationship was estimated for all years (Figure 6.8.1.2.1 and Figure 6.8.1.2.2). While the *b*-values and t-test results indicated positive allometric growth for all samples, the *b*-values showed no significant difference for years (*P* > 0.05) (Figure 6.8.1.2.3).

Table 6.8.1.2.1. VBGF parameters was calculated for caught Atlantic bonito (*Sarda sarda*) in the Turkishcoast of Black Sea between 2000-2013 (TL: total length), (L_∞ in cm, k in y-1, t0 in y).

Parameters	2000	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013
K	0.76	0.39	0.57	0.71	0.68	0.70	0.34	0.72	1.19	0.92	1.08
L_∞	72.89	95.26	77.00	73.64	82.55	73.87	99.70	73.62	65.90	72.60	69.24
To	-0.23	-0.34	-0.29	-0.25	-0.23	-0.25	-0.38	-0.25	-0.17	-0.20	-0.17
A	0.0044	0.0034	0.0027	0.0034	0.0037	0.0063	0.0021	0.0038	0.0038	0.0037	0.0024
B	3.3282	3.3607	3.3871	3.3109	3.2831	3.2040	3.4464	3.2705	3.2873	3.2806	3.4115
M	0.717	0.432	0.583	0.688	0.643	0.679	0.388	0.689	0.989	0.812	0.917
N	1110	673	40	391	304	284	275	610	491	907	477

Table 6.8.1.2.2. VBGF parameters was calculated by different authors for Atlantic bonito (*Sarda sarda*) from different areas (FL: fork length; TL: total length), (L_∞ in cm, k in y-1, t0 in y).

Author(s)	Area	Length Type	L_∞	k	to	Φ'
Zusser (1954)	Black Sea (Russia)	FL	103.0	0.13	–1.80	3.14
Nümann (1955)	Black Sea (Turkey)	FL	67.8	0.79	-	3.56
Nikolsky (1957)	Black Sea (Turkey)	FL	81.5	0.52	-	3.54
Türgan (1958)	Black Sea (Turkey)	FL	64.0	0.86	-	3.55
Nikolov (1960)	Black Sea (Bulgaria)	FL	95.6	0.24	–1.24	3.34
Dardignac (1962)	Atlantic (Morocco)	FL	64.0	0.69	–1.42	3.45
Rey et al. (1986)	Gibraltar Strait (Spain)	FL	80.8	0.35	–1.70	3.36
Zaboukas and Megalofonou (2007)	Eastern Mediterranean (Greece)	FL	82.9	0.24	–0.77	3.22
Ateş et al. (2008)	Black Sea and Marmara Sea (Turkey)	TL	68.0	0.82	–0.39	3.58
Cengiz, 2013	Çanakkale (Turkey)	TL	69.8	0.76	–0.44	3.57
Karahan et all., 2014	Black Sea and Marmara Sea (Turkey)	FL	67.9	0.46	–1.22	3.33

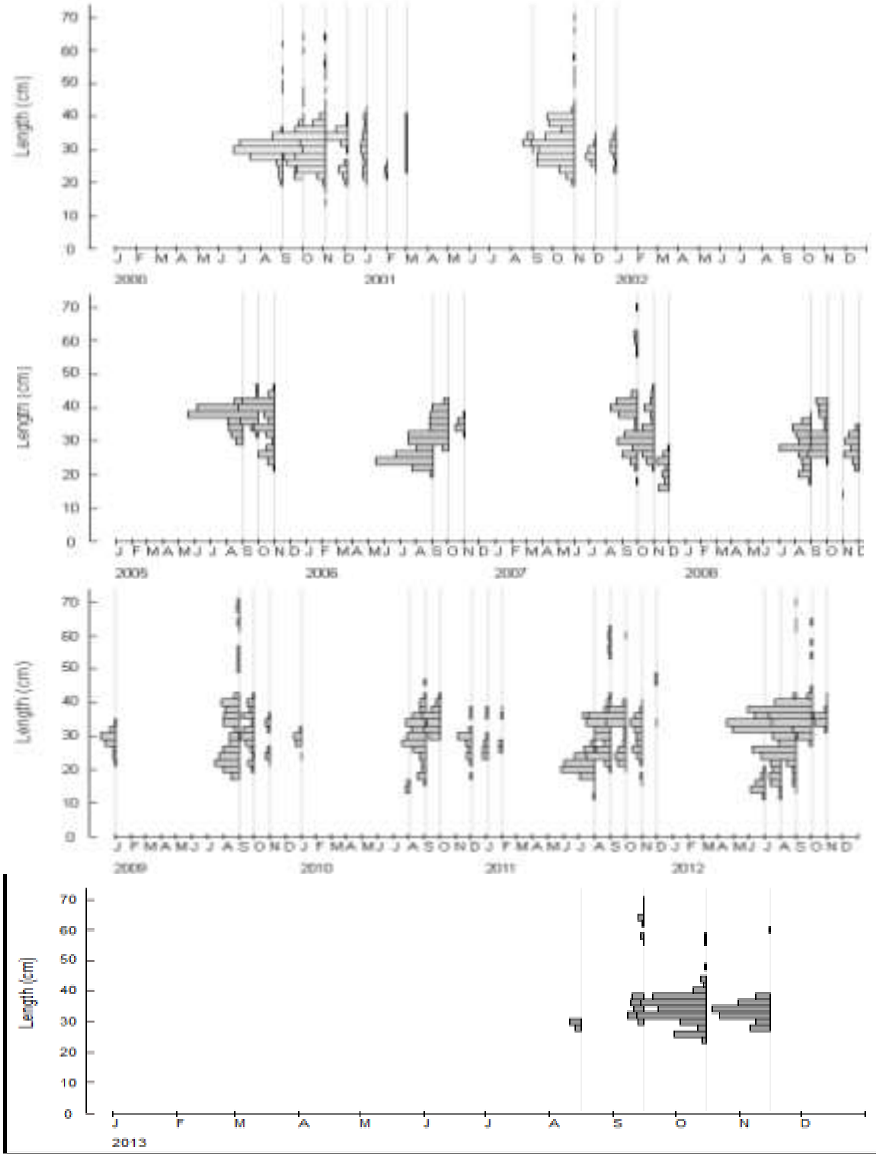


Figure. 6.8.1.2.1. Monthly length distributions of Atlantic bonito (*Sarda sarda*) in the caught from the Turkey waters of the Black Sea and Sea of Marmara from 2000 to 2013 years

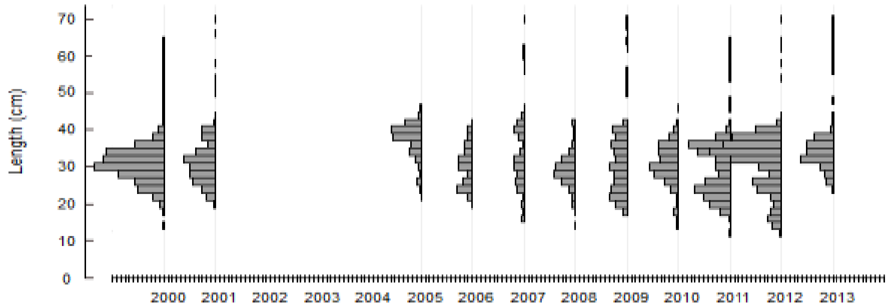


Figure 6.8.1.2.2. Growth curve of Atlantic bonito (*Sarda sarda*) in the Turkey waters of Black Sea and Sea of Marmara between 2001-2013 years

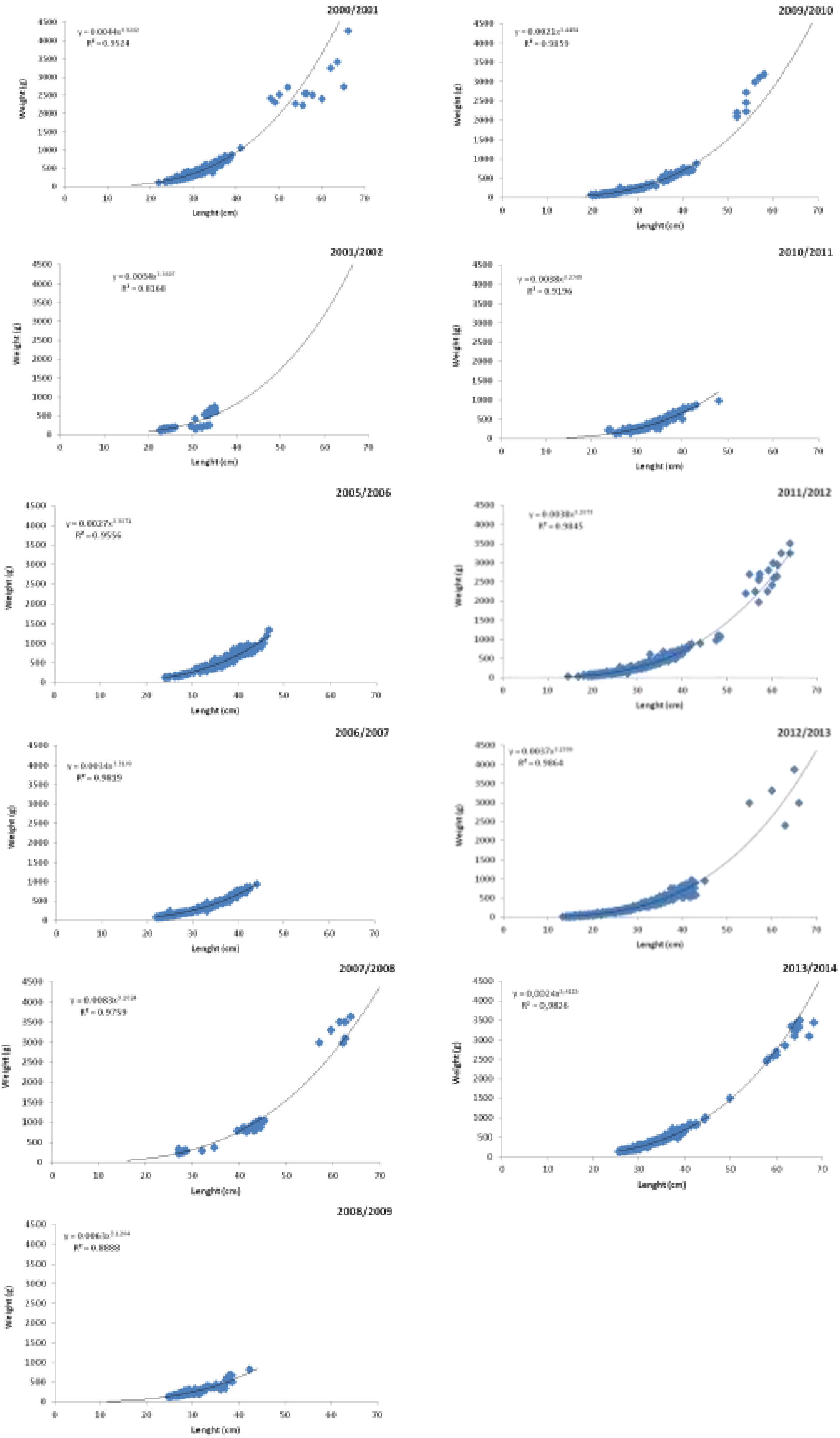


Figure 6.8.1.2.3. The length-weight relationship in Atlantic bonito (*Sarda sarda*) for Turkish waters of the Black Sea and Sea of Marmara, all Fisheries Season

The length and weight frequency distributions for Turkish waters were presented in Figure 6.8.1.2.4. Age distribution ranged from 0 to 3 years. Year class 0 (70.61%) was dominant, followed by year classes I (28.25%), II (0.82%), and III (0.32%).

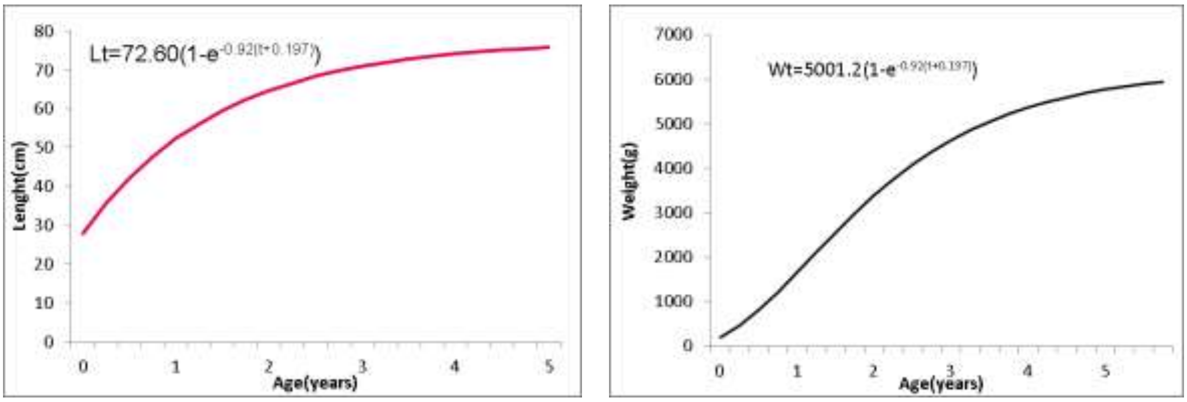


Figure 6.8.1.2.4. The age-length relationship in Atlantic bonito (*Sarda sarda*) for Turkish waters of the Black Sea, 2013 Fisheries Season

6.8.1.3 Maturity

No maturity studies conducted.

6.8.2 Fisheries

6.8.2.1 General Description

A fleet profile of the Black Sea Turkish fishing is published every year by TUIK. In 2013, there were 4.879 vessels operating in the Black Sea of which 351 trawlers, 197 purse seiners, 89 transporter vessels and 4.242 small-scale vessels. The numbers of vessels over 20 m length were 197 and targeting on a seasonal basis pelagic species like anchovy, horse mackerel, Atlantic bonito and blue fish. In the Black Sea and Marmara Sea, the major taxa landed by the large scale sector for the 1950-2013 periods include anchovy (73%), horse mackerel (10%), Atlantic bonito (5%), whiting (4%), blue fish (3%) and sprat (2%) (TUIK, 1950-2014).

In Turkey, fishing season is from 01 September to 15 April. Atlantic bonito fisheries are at their peak in September and October by purse seine and gill nets. When anchovy fisheries start bonito fisheries decrease. For wintering migration, bonito returns to the Marmara Sea and Aegean Sea at the end of October following a decrease of water temperature (Figure 6.8.2.1.1).

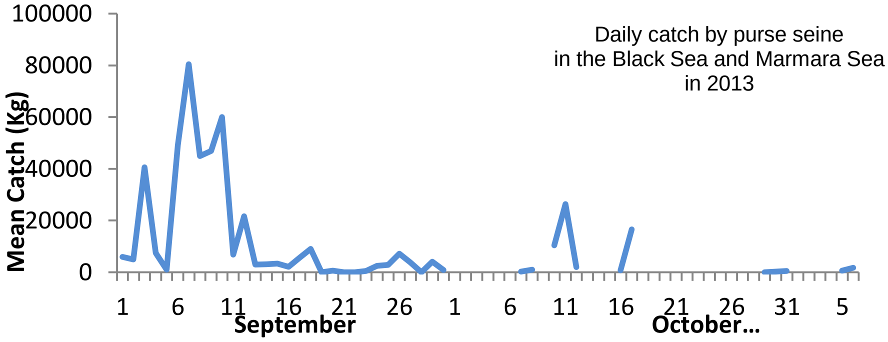


Figure 6.8.2..1.1. Daily mean catch amount of Atlantic bonito (*Sarda sarda*) by purse seine in the 2013 fisheries seasonal, in the Black Sea and Sea of Marmara.

6.8.2.2 Management regulations applicable in 2012 and 2013

Fisheries activities are regulatied by the Commercial Fishery Advice of General Directorate of Fishery in Turkey.

- **Regulations about fishing area:** For purse seines, it is not allowed in waters shallower than 24 m.
- **Regulations about fishing gear:** The depth of purse seine net cannot be more than 164 m. The use of gill nets for bonito is permitted between 15 and 31 August.
- **Regulations about time periods:** Fishing period of purse seine is from 1 September to 15 April. The use of fixed nets is prohibited in the Turkish territorial waters from 15 April to 31 August
- **Legal size:** The minimum size for the Atlantic bonito is 25 cm in Turkey and 28 cm in Bulgaria.

6.8.2.3 Catches

6.8.2.3.1 Landings

In Turkey, the declared landings of Atlantic bonito in the last years are the following: 6322 tons in 2010; 6726 tons in 2011; 29854 tons in 2012; 10601 tons in 2013 (Figure 6.8.2.3.1; Figure 6.8.2.3.2; Figure 6.8.2.3.3) and (Table 6.8.2.3.1.)

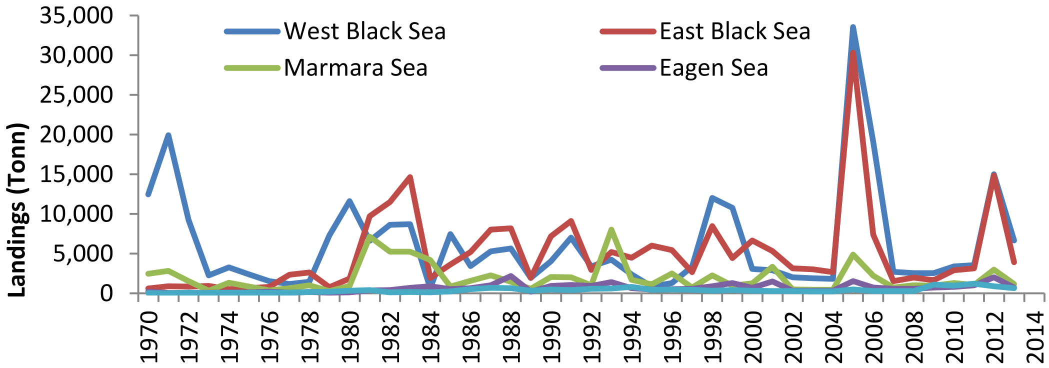


Figure 6.8.2.3.1. Landings distribution of Atlantic bonito (Sarda sarda) in the Turkish Seas

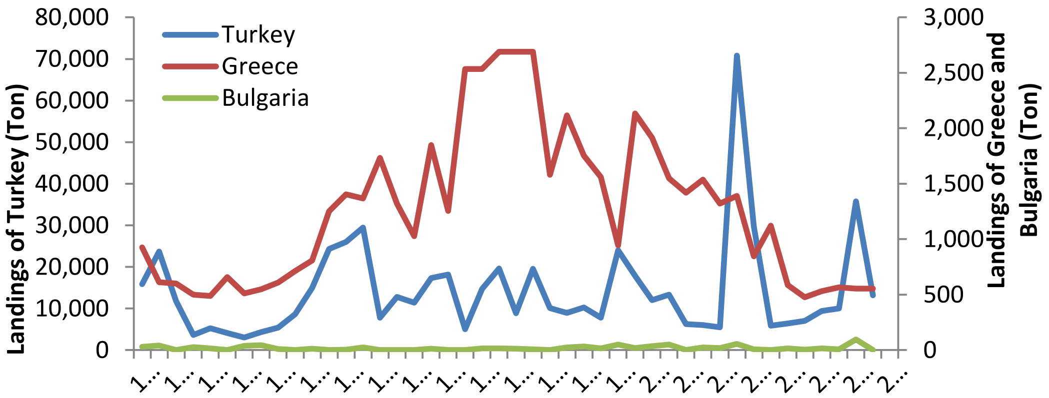


Figure 6.8.2.3.2. Landings distribution of Atlantic bonito (Sarda sarda) in Turkey, Greece and Bulgarian Seas

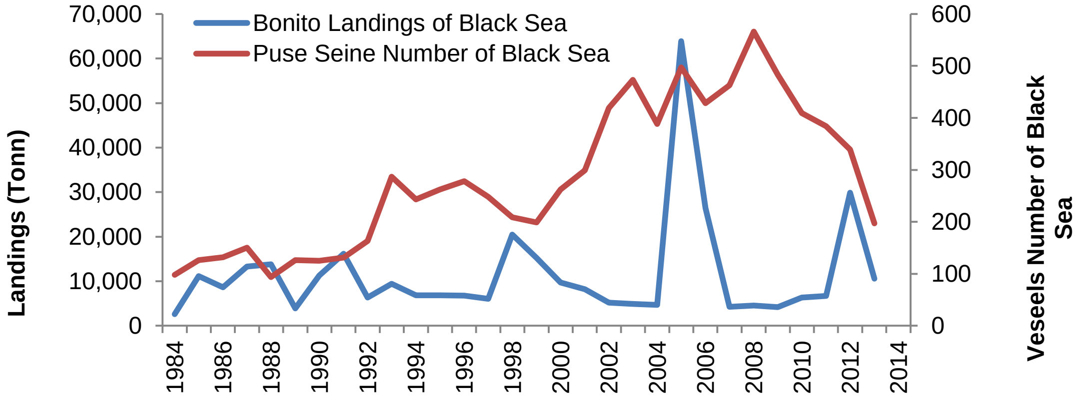


Figure 6.8.2.3.3. Comparisons of purse seine vessel and landings of Atlantic bonito (Sarda sarda) in the Black Sea, Turkey.

Table 6.8.2.3.1. Landings of Atlantic bonito (*Sarda sarda*) in Turkishcoasts

Year	Turkish Seas (Tones)					Country (Tones)		
	West Black Sea	East Black Sea	Marmara Sea	Aegean Sea	Mediterranean Sea	Turkey	Greece (Aegean Sea)	Bulgaria
1970	12.486	596	2.476	215	59	15.832	927	30
1971	19.935	900	2.829	35	16	23.716	611	41
1972	9.246	846	1.534	32	97	11.755	600	0
1973	2.269	939	327	73	45	3.654	500	28
1974	3.261	526	1.338	91	72	5.287	487	15
1975	2.399	674	847	149	72	4.140	658	0
1976	1.555	829	363	207	72	3.025	511	40
1977	1.162	2.332	664	78	104	4.339	550	44
1978	1.451	2.629	1.014	175	163	5.431	610	11
1979	7.294	782	283	82	198	8.639	712	1
1980	11.605	1.882	939	151	333	14.910	809	13
1981	6.604	9.733	7.165	367	432	24.300	1.251	0
1982	8.629	11.522	5.262	432	133	25.978	1.405	4
1983	8.701	14.668	5.237	695	184	29.485	1.367	24
1984	664	1.938	4.196	889	131	7.818	1.732	1
1985	7.486	3.640	871	547	265	12.809	1.321	1
1986	3.422	5.226	1.572	675	531	11.426	1.027	0
1987	5.287	8.026	2.288	1.018	714	17.333	1.848	13
1988	5.647	8.186	1.448	2.178	674	18.133	1.254	0
1989	1.936	1.936	592	219	325	5.008	2.534	0
1990	4.057	7.199	2.056	947	478	14.737	2.534	17
1991	7.030	9.114	2.037	1.057	407	19.645	2.690	15
1992	3.399	2.938	1.028	920	578	8.863	2.690	12
1993	4.248	5.213	8.054	1.419	614	19.548	2.690	8
1994	2.385	4.492	1.713	670	833	10.093	1.581	0
1995	861	6.005	1.125	508	445	8.944	2.116	25
1996	1.285	5.467	2.502	534	496	10.284	1.752	33
1997	3.362	2.682	738	565	463	7.810	1.559	16
1998	12.019	8.461	2.276	897	347	24.000	945	51
1999	10.775	4.458	961	1.303	403	17.900	2.135	20
2000	3.084	6.653	1.248	692	322	11.999	1.914	35
2001	2.905	5.332	3.345	1.491	287	13.360	1.550	49
2002	2.016	3.159	479	350	282	6.286	1.420	0
2003	1.924	3.015	457	335	269	6.000	1.538	23
2004	1.828	2.685	434	318	256	5.521	1.321	18
2005	33.572	30.324	4.878	1.536	487	70.797	1.390	56
2006	19.092	7.373	2.208	742	277	29.692	845	8
2007	2.707	1.539	731	590	298	5.865	1.123	1
2008	2.565	1.971	1.006	594	312	6.448	587	16
2009	2.535	1.681	983	754	1.083	7.036	476	5
2010	3.408	2.914	1.304	809	966	9.401	531	16
2011	3.555	3.171	1.054	1.004	1.235	10.019	277	8
2012	14.991	14.863	3.008	2.015	886	35.763	555	96
2013	6.671	3.930	1.180	732	645	13.158	615	0

6.8.2.3.2 Discards
No discards have been reported for the Atlantic bonito fishery.

6.8.2.4 Fishing effort
6.8.2.5 Commercial CPUE

6.8.3 Scientific surveys
No specific fisheries independent scientific surveys have been conducted

6.8.4 Assessment of historical parameter
6.8.4.1 Method 1: ASPIC
6.8.4.2 Justification
6.8.4.3 Input parameters

Table 6.8.4.3.1. Data availability by country

Type of data	BG	TR	Selection for Assessment	Comments
Official landings	Yes	1982-2013		
Illegal, Unreported Catch	No	No		
Fishing effort and CPUE	No	2013		
Number of fishing vessels	No	1996-2013		
Research surveys –adult	No	No		
Reserch surveys –juvenile	No	No		
Hydroacoustic surveys	No	No		
Length composition	No	2001-2013		
Weight at length (survey, landings)	No	2001-2013		
Age composition	No	2001-2013		
Weight at age (survey, landings)	No	2001-2013		
Maturity at age	No	No		
Natural mortality	No	Yes		

Availability of Data for assessment

Catch at age

Table 6.8.4.3.2. Aggregated catch at age in number 10^{-3} of Turkey.

Year	Age-0+	Age-1	Age-2	Age-3
2000	7735.035	9551.772	1323.712	372.0833
2001	8513.704	10741.02	0	3183.519
2002				
2003				
2004				
2005	3364.883	94235.96	0	0
2006	28425.79	49498.43	0	0
2007	230.7439	1489.976	1493.865	374.3538
2008	11507.07	5513	0	0

2009	4044.66	3960.605	2276.431	465.6385
2010	6199.694	10633.11	0	0
2011	4665.997	10457.62	2866.445	497.8718
2012	9842.11	56652.81	1296.113	1382.787
2013	2420.415	8916.019	246.9811	197.5849

Weight at age in the catch

Table 6.8.4.3.3. Weight at age in the catch (in g).

Year	Age-0+	Age-1	Age-2	Age-3
2000	371.581	612.7929	2632.6	3700
2001	205.7158	562.3243		5000
2002				
2003				
2004				
2005	226.2813	702.1296		
2006	210.3911	524.6252		
2007	275	887.8746	3306.429	5800
2008	218.2993	494.4091		
2009	206.3588	580.5513	2627.75	4300
2010	260.2305	506.4648		
2011	153.7717	544.0284	2594.667	3380
2012	178.7153	542.6042	3240	3456.667
2013	5748.035	12248.25	64449.73	82862.17

Table 6.8.4.3.4. Atlantic bonito maturity at age.

Age	%Mature	M
0+	0	2.259936
1+	1	0.954501
2+	1	0.743604
3+	1	0.679564

6.8.4.4 Results

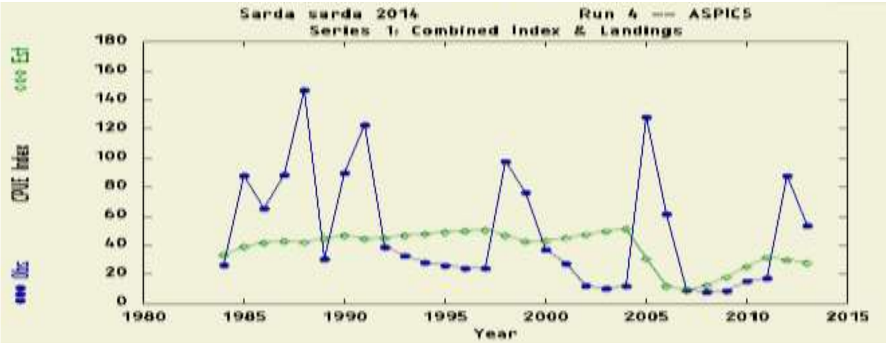


Figure 6.8.4.4.1 Atlantic bonito (*Sarda sarda*) of observed vs. estimated results was calculated by ASPIC in the Black Sea and Sea of Marmara

Estimated contrast index (good=0.5, best=1.0): **0.7718** Mean of B coverage proportions > and < Bmsy

Estimated nearness index (best=1.0): 1.0000 Proportional closeness of B to Bmsy

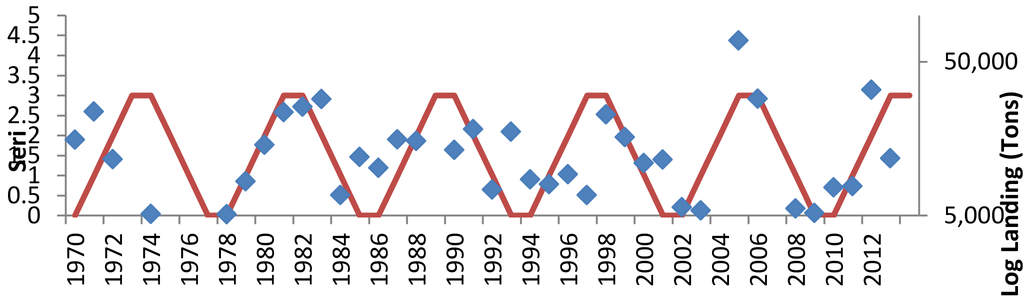


Figure 6.8.4.4.2 Time series for landing of Atlantic bonito (*Sarda sarda*) (1970-2013) in the Black Sea and Sea of Marmara (According to TUIK dates)

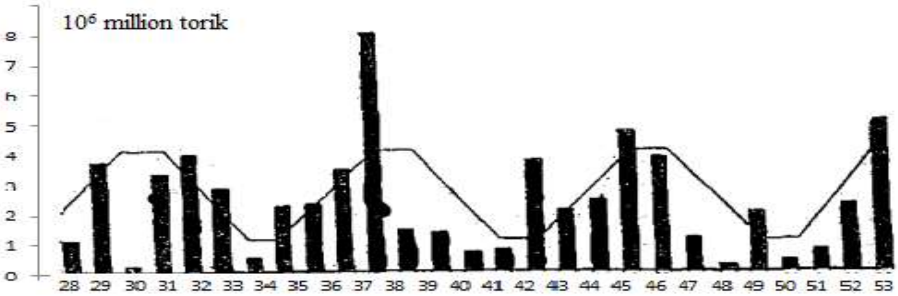
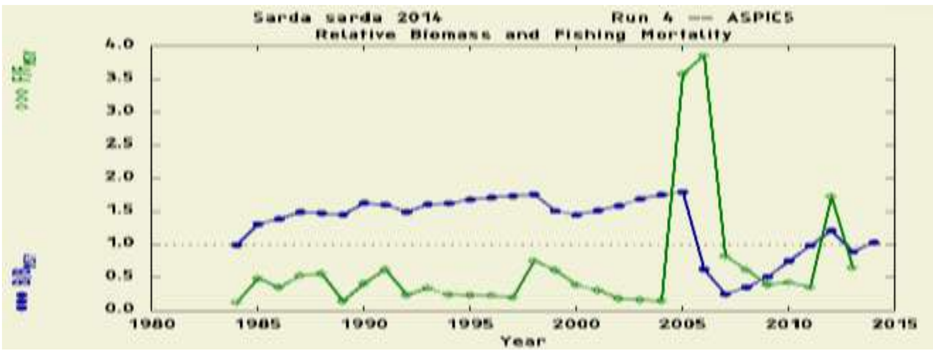
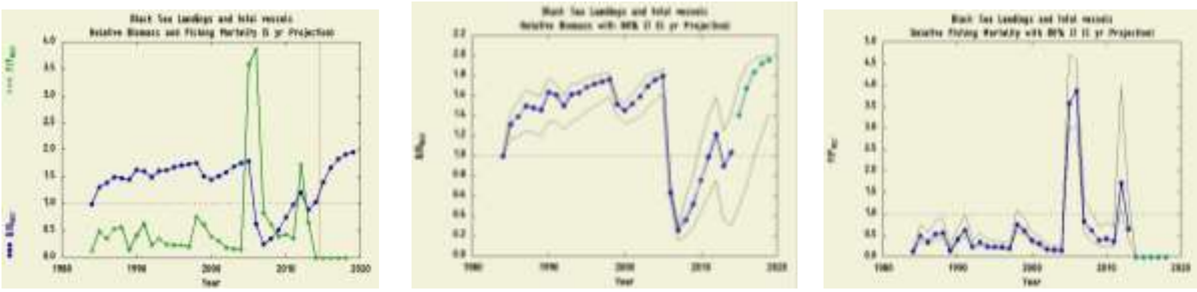


Figure 6.8.4.4.3 Time series for landing of Atlantic bonito (*Sarda sarda*) (1928-1953) in the Black Sea and Sea of Marmara (from Artüz, 1957)

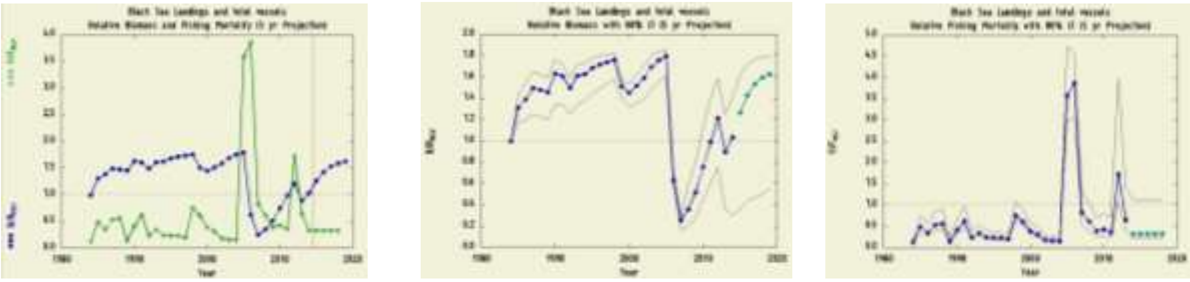


B/Bmsy, F/Fmsy

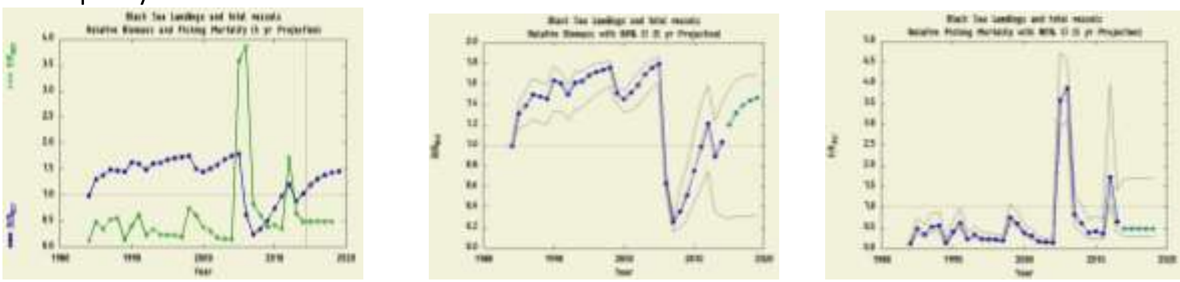
Figure 6.8.4.4.4 F is below Fmsy except 2005 and 2006, 2012. Biomass is above Bmsy until 2005 then reduced below msy and gradually increased.



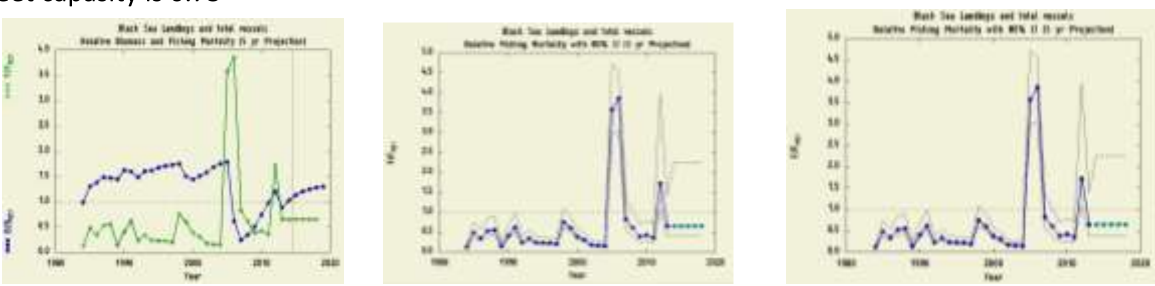
Fleet capasity is 0



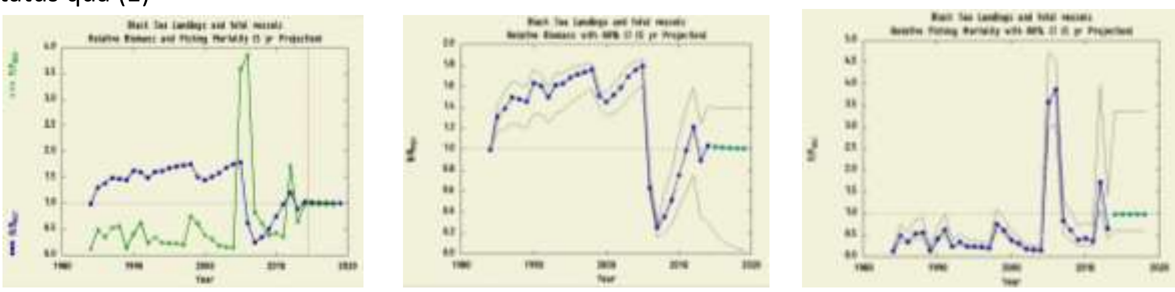
Fleet capasity is 0.5



Fleet capasity is 0.75



Status qua (1)



Fmsy x 1.5, (0.392/0.259)

Figure 6.8.4.4.5. Projection for next five years for Atlantic bonito (*Sarda sarda*) calculated by ASPIC Program

6.8.5 Scientific advice

The EWG was not able to develop a quantitative assessment for this stock. However, information on the length frequency of the Turkish landings of bonito was assembled and growth curves were developed. The accuracy of the age determinations that underlie the growth curve estimates remains highly uncertain, particularly for the older fish, because of the scarcity of large fish. Given the absence of any biological reference points for this stock or estimates of spawning stock biomass, the EWG 14-14 was unable to evaluate the stock status.

6.8.5.1 Short term considerations

Although a 5-year projection for this stock was performed using the ASPIC software, the EWG did not cosider it to be sufficiently reliable to inform management decisions given the unusual cyclical dynamics apparent in the landings series.Medium term considerations

6.9 RAPA WHELK IN GSA 29

6.9.1 Biological features

6.9.1.1 Stock identification

Rapa (veined) whelk *Rapana venosa* (Val., 1846) *(syn. Rapana thomasiana* Crosse, 1861- mainly used in former USSR and *Rapana pontica* Nordsieck, 1969) (DAISIE, 2009) was introduced into the Black Sea in the 1940s and spreaded along the Caucasian and Crimean coasts and to the Sea of Azov within a decade. Its' range extended into the northwest Black Sea to the coastlines of Romania, Bulgaria and Turkey from 1955 to 1969 (Fig. 6.9.1.1.1) **(**Global Invasive Species Database) (http://www.issg.org/database)**.** *R. venosa* is well established in the benthic ecosystem of all the Black Sea coastal states and has exerted significant predatory pressure on the indigenous malacofauna (Black Sea TDA, 2008).

Fig. 6.9.1.1.1 Distribution area and time of Rapa whelk in the Black Sea (Novorosisk (1947), Crimea (1949), Romania (1955), Bulgaria (1957), Istanbul (1960), Marmara (1966), Aegean (1969), Giresun (1955), Trabzon (1962)).

After the adaptation in the Black Sea ecosystem, it has formed dynamic stocks along the whole Southern Black Sea coasts since 1969 (Bilecik, 1975). The whelk population has spread gradually onward the 1970's and also its stock has started increasing in coastal benthic habitats extremely in 1980s. Rapa whelk has established and exrets pressure on the bivalve communities through predation in the shallow waters of the Black Sea coast of Turkey (Bilecik, 1990).

R. venosa is a prolific, extremely versatile species tolerating low salinities, water pollution and oxygen deficient waters. Veined Rapa whelk becomes mature at the age of 2-3 and has an 8-9 years life span. Preferred habitats are shell substrates and shell bottoms with varying degrees of silting, but on the silt beds the Rapa whelk occurrence is not high. The species tolerates low salinity with the lower limit of its development about 12 ‰ and also a range of temperatures-at low temperatures the activity of Rapa whelk falls and if the temperature falls below10°C, the species stops feeding. Local migrations of Rapa whelk have been associated with seasonal changes of water temperature and have been oriented towards the shore in the period of water heating during spring-summer season, and towards deeper waters in the autumn-winter cooling.

Ciuhcin (1984) describes the reproductive period of *R. venosa* in the Black Sea from July to September, corresponding to 19^{o}C to 25^{o}C. Females lay eggs in cocoons attached to the substrate. Each egg capsule contains 200-500 eggs. Pelagic larvae feed on nanoplankton algae and their adults feed mainly on bivalves of families Cardiidae, Mytilidae, Veneridae, Archidae (GFCM:SAC12/2010). Looking for prey, Rapa whelk is able to move on rather large distances. The speed of movement ranges from 5 to 20 cm/min. In some periods of the year it buries itself into the bottom.

Introduction of this predatory mollusk into the ecosystem of the Black Sea turned out to be a catastrophe for oyster biocenoses. Distribution of Rapa whelk is associated with reduction of mussel banks particularly near the coasts of Anatolia and Caucasus. In the Ukrainian waters, Rapa Whelk destroyed the oyster banks in the area of the Kerch Strait and in Karkinitsky Bay, biocenoses of other mollusks associated with depth down to 30 m suffered as well.

The impact on bivalve populations is variable and ranges from rather mild along the Romanian coast possibly due to suboptimal environmental condition, moderate in Bulgarian and Turkish Black Sea, and severe along Russian and Ukrainian coasts, where the whelk has been blamed for local exterminations or major declines in the numbers of other bivalves (Black Sea TDA, 2008).

In the Black Sea, *Rapana venosa* occurs on sandy and hard-bottom substrates to 45 m depth. The highest abundance occurs in the Kerch Strait at the entrance to the Sea of Azov, near Sevastopol and Yalta (Ukraine), and along the Bulgarian coast (ICES, 2004). In the Black Sea coasts of Turkey, it was observed that 74% of the stocks were found up to 10 m, 24% between 10-20m and 2% deeper than 20 m of depth (Duzgunes et al., 1992).

Turkish investigations concerning biomass distribution of Rapa whelk by depth and season indicates that 76.5% of the population inhabits the depths of 0-15 m from the shore, 22.5 % in 15-35 m and the last 1.0% is in depths over 35m. The major factor for seasonal distribution is the sea water temperature. In summer, 62.5% of the population was found in near shore of 0-15 m depths when the temperature reaches its maximum. By the end of the reproduction activity and the decrease in sea water temperature, generally after September, Rapa whelk moves to deeper waters and buries in substratum.

Rapa whelk has no effective natural predator in Black Sea (as sea stars) and this is the main reason of fast population increase and invading speed. Its feeding strategy depends dominantly on mussels (Cesari and Mizzan, 1993) and its high rate of predation depleted nearly all bivalve stocks (*M. galloprovincialis, Chamelina gallina, Anadara cornea*) along the coasts from Georgia border to Samsun province. It is reported that 99% of *C. gallina* population is composed of empty shells in the period of 2002/2003 (Dalgıç and Karayücel, 2006).

In the by-catch assessment surveys in Rapana dredges the percentage of empty shells was recorded to 73% and 85% for *Anadara cornea* and *Chamelea gallina*, respectively (Knudsen and Zengin, 2006). Recently, Rapa whelk started to threaten some other mollusca and crustacean communities (*L. depurator*, Donax sp., Isopods, Amphipods and Decapods). It also threatens another exotic Pacific originated species; *Anadara cornea* that invaded the Black Sea ecosystem in 1982.

6.9.1.2 Growth

According to the investigations conducted in the Black Sea shelf area and Kerch Strait, it is determined that maximum age, length and weight of Rapana is 8 years, 112 mm and 320 g, respectively. According to the Ukrainian expert data (for 2012) age, length and weight of Rapana were summarized in Table 6.9.1.2.1 and Fig. 6.9.1.2.1.

In Turkey, data on size groups are used for the determination of the growth. In order to estimate growth parameters of the population living in Turkish coasts, age at length key of Ukraine is used to estimate averaged lengths in different size intervals.

Table 6.9.1.2.1. Length (mm) and weight (g) at age in Ukrainian waters from 2003 – 2007

	2003	2004	2005	2006	2007	2008

Age	L	W	L	W	L	W	L	W	L	W	L	W
2	72,1	73,7	74,5	82,5	81,3	88,6	61,8	50,8	62,2	44,5	72,5	79,3
3	80,5	115,0	74,6	99,0	81,4	107,3	67,3	65,9	62,2	55,4	81,7	111
4	82,9	127,1	83,7	134,5	82,9	118,8	69,1	73,2	80,5	101,2	87,0	162
5	88,2	160,0	87,6	160,5	83,7	130,0	74,4	95,0	83,7	126,7		
6	92,3	182,5	97,7	208,4	95,4	187,5	77,5	104,2	95,0	185,0		
7	109,0	282,5	108,5	195,0	93,0	191,0	85,5	135,0				
8					82,0	140,0	80,0	115,0				
9			112,0	320,0								

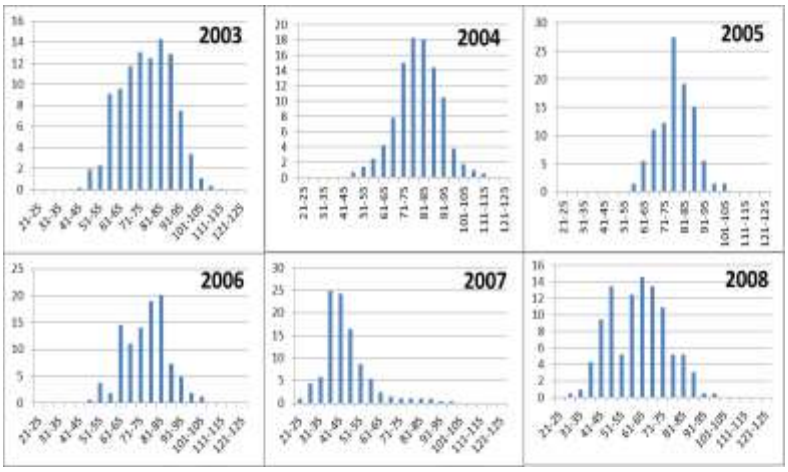


Fig. 6.9.1.2.1. Length frequencies of Ukrainian catch by years.

Maximum age was determined as 8 and population growth parameters were given as L_∞=131.3 mm, K=0.3015 and t_0=-2.6798 (for 2003 as the best fitting data of age length key) by YugNIRO Institute in Kerch. Other years were not accounted for due to “insufficient input data for the average length at age”.

In Turkey, length frequencies are given in Fig. 6.9.1.2.2. Size groups are used for the determination of the growth. In order to estimate growth parameters of the population living in Turkish coasts, age at length key of Ukraine is used to convert length data to age (Table 6.9.1.2.2).

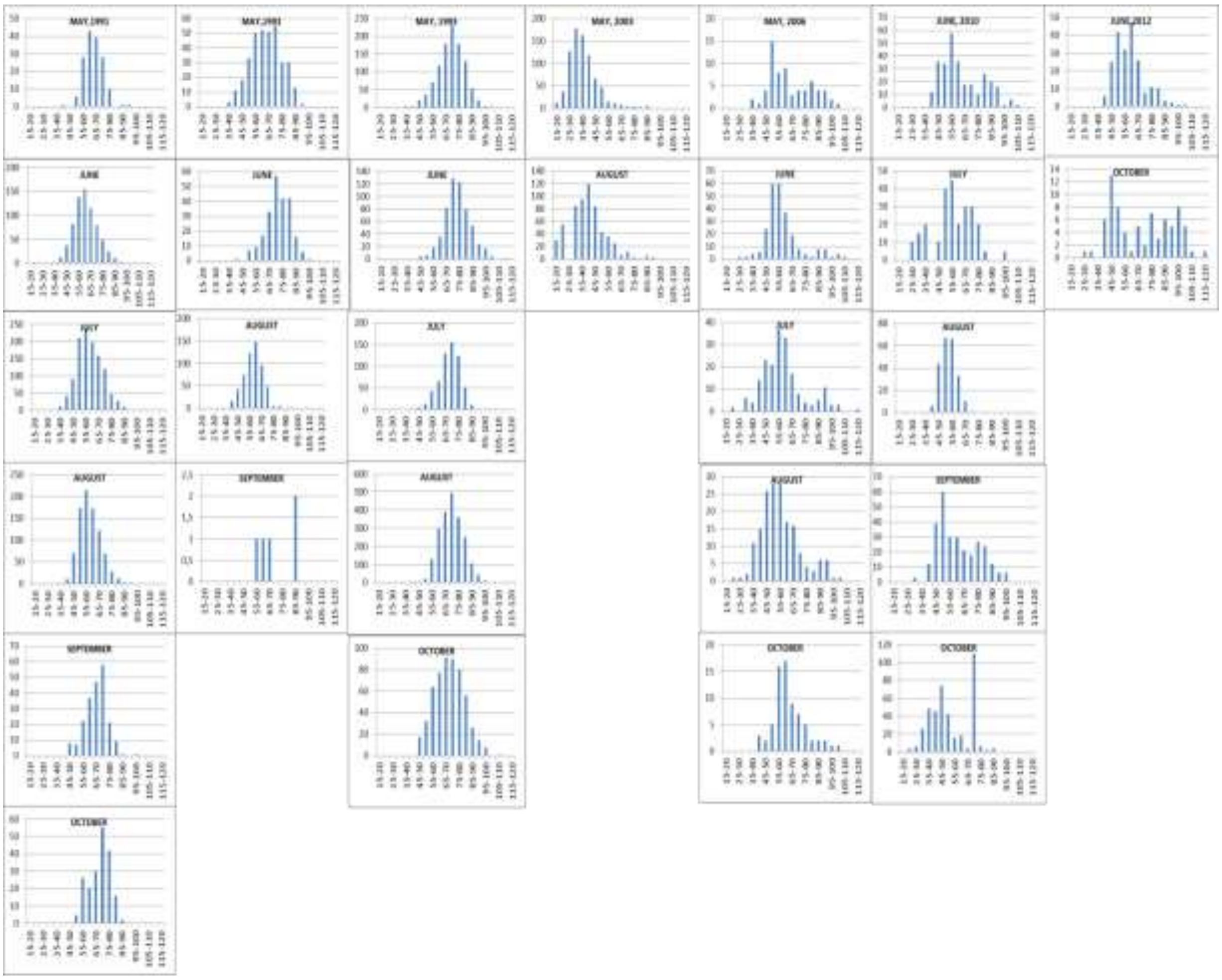


Fig. 6.9.1.2.2. Length frequency distribution of Rapa whelk stocks in the Black Sea coasts of Turkey

Table 6.9.1.2.2. Length at age data for Turkey transformed by using age length key of UA -2003 data

Ages	1991	1992	1993	2003	2006	2010	2012
1	41,63	42,02	41,25	39,90	44,21	42,29	45,67
2	57,84	58,80	64,50	51,90	51,90	57,98	57,65
3	70,63	72,63	73,59	68,59	68,59	71,36	70,16
4	80,47	81,95	74,40	75,87	75,87	75,32	75,20
5	85,74	104,09	82,61	83,90	83,90	87,59	92,37
6			118,86	89,46	89,46	89,29	89,84
7						107,50	115,02

Maximum age in the population was estimated as 7 by this method.

In Turkey, Rapa whelk population varied from 24 to 96 mm in shell length, and mean length and weight were found as 62.3 mm, 47.2 g, respectively (Duzgunes et al., 1992). Length- weight relationships for some years were given in Fig. 6.9.1.2.3 and Fig. 6.9.1.2.4 in Ukraine and Turkey.

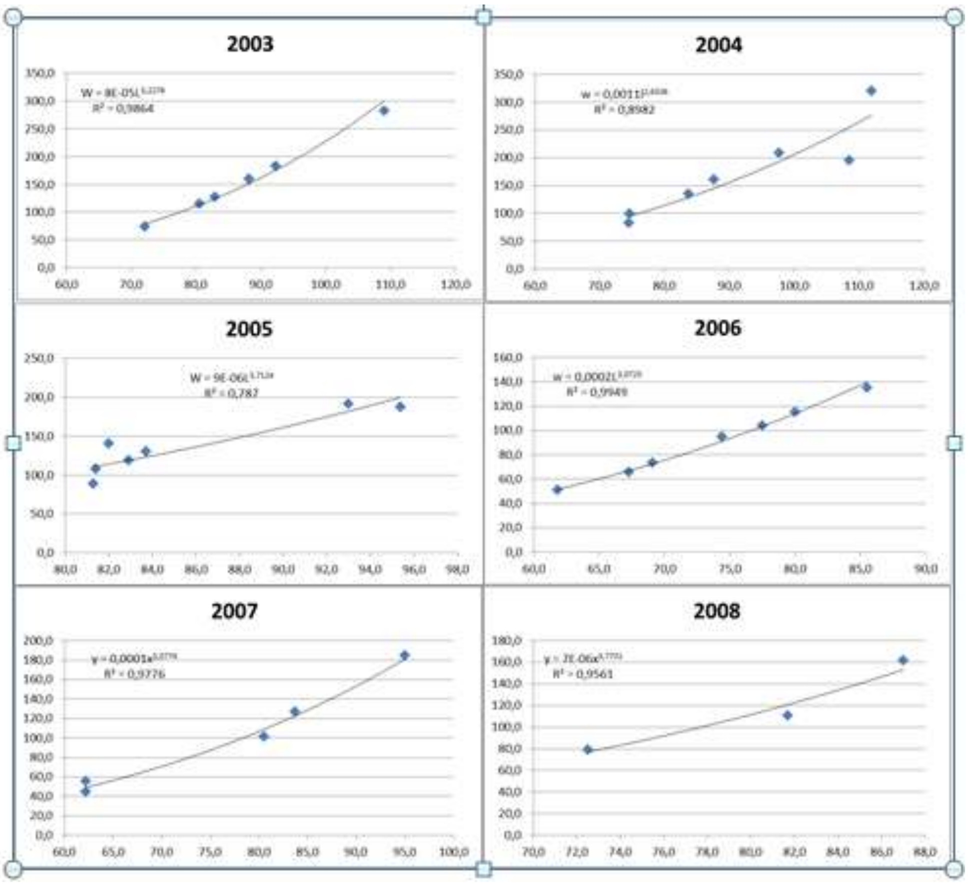


Fig. 6.9.1.2.3. Length and weight relationship of Rapana in Ukraine by years

Saglam (2003), reported that the mean length, weight was 52.85 mm and 27.72 g respectively. This decrease in mean length could be by competing with native species for food and space or lack of sufficient food for high Rapa whelk populations. The average shell length of Rapa whelk at 0-10 m and 10-20 m depths was 62.9 mm and 60.9 mm respectively, while it was 54.8 mm at >20 m depths.74 % of Rapa whelk was found at 0-10 m depths. %24 and %2 of the population were at 10-15 m and at>20 m depths respectively. It is a typical inhabitant of coastal waters (Duzgunes et al., 1992). Growth parameters of Rapana are summarized in Table 6.9.1.2.3 and in Fig. 6.9.1.2.5.

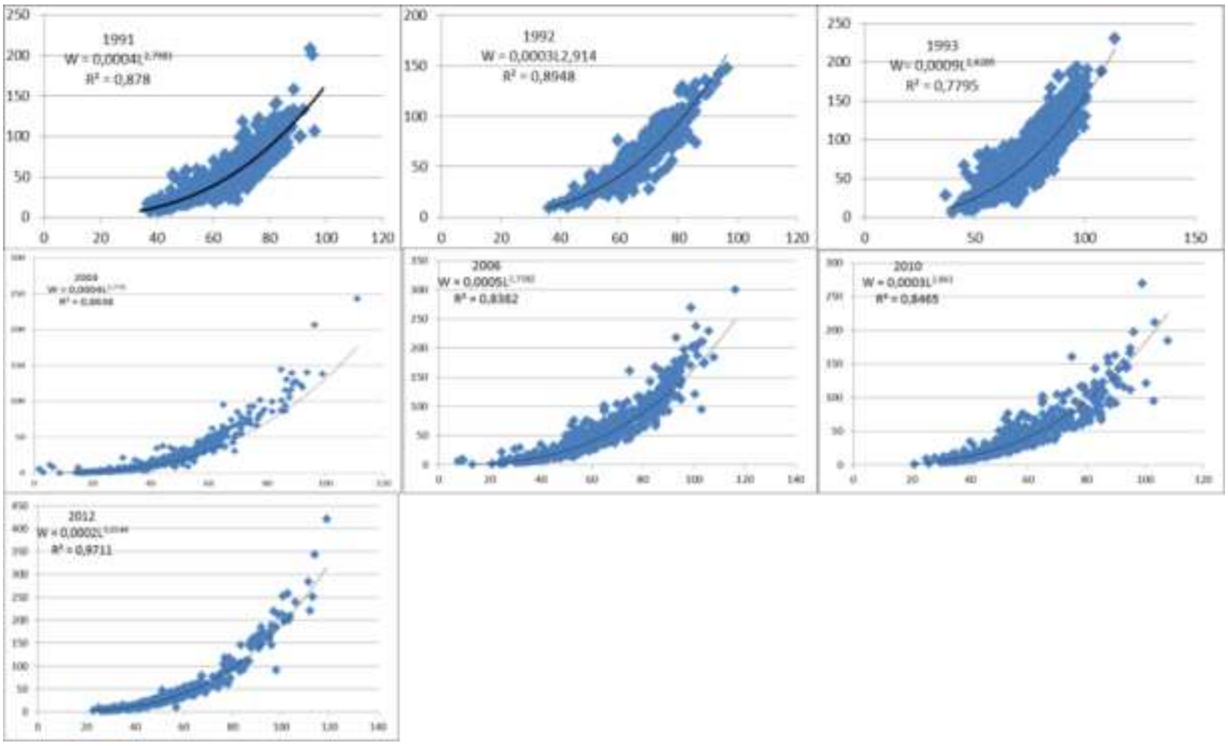


Fig. 6.9.1.2.4 Length weight relationship of Rapana in Turkish Black Sea coast

Table 6.9.1.2.3. Growth parameters of Rapana in the Black Sea <u>For Turkey</u>

Parameters	1991*	1992	1993**	2003*	2006*	2010**	2012**
L_∞	98.29	is not	124.58	98.40	98.40	100.65	104.04
W_∞	150.40	fitting		138.22			
K	0.388	well	0.119	0.397	0.397	0.331	0.307
t_0	-1.972		-3.781	-1.829	-2.098	-2.194	-2.458
a***	0.0004	0.0003	0.0009	0.0004	0.0005	0.0003	0.0002
b***	2.798	2.914	2.6285	2.779	2.758	2.863	3.0144

*fitting best, ** fitting if the last age group excluded *** length- weight relationship coefficients

For Ukraine

Parameters	2003	2004	2005*	2006*	2007*	2008*
L_∞	131.3	137.4				
W_∞						
K	0.3015	0.2829				
t_0	-2.6798	-2.8761				
a***	0.00008	0.011	0.000009	0.0002	0.0001	0.000007
b***	3.2276	2.6336	3.7124	3.0725	3.0774	3.7731

*poor data

For Bulgaria

Parameters	1994
L_∞	123.98
W_∞	423.75
K	0.214
t_0	-0.0822
M	0.5

The average natural mortality coefficient was estimated as 0.5 by Prodanov et.al.,(1995) for Bulgaria.

Though it has high tolerance to temperature variations, they tend to burry themselves in sand from late autumn till late spring and they approach to the coasts after May. All individuals become available for harvesting. In summer months the abundance of Rapa whelk was calculated to 0.42 indv/ m^2 in sandy regions dredged by the swept area method. Whereas the density of Rapa whelk in rocky regions was as high as 14 indv/ m^2 compared to that in sandy regions (Duzgunes et al., 1992). The high abundance of rapana in rocky regions in summer is due to migration towards hard substratum to spawn.

Prodanov and Konsulava (1995) reported that the commercial stock biomass and TAC of Rapa whelk are about 7482.6 and 3217.5 tons respectively in Bulgarian Black Sea coast. Also they suggested that the most suitable period for conducting such assessments is July.

Growth and mortality parameters were given as K=0.3015 t_0=-2.6798; L_∞= 131,3 mm; M_t: M_2= 0.12. M_3= 0.54; M_4= 1.28. M_5= 1.40 by Ukranian experts (from 2010 EWG report). Overall M reported as 0.57 based on the surveys conducted in Turkey (Saglam et al, 2014). According to the 2010 data (which is best fitting in recent years) W= $0.003L^{2.863}$ (R^2=0.8465). The parameters of a and b are rather different compared tothe Ukrainian due to their data based on average weight and lengths to ages.

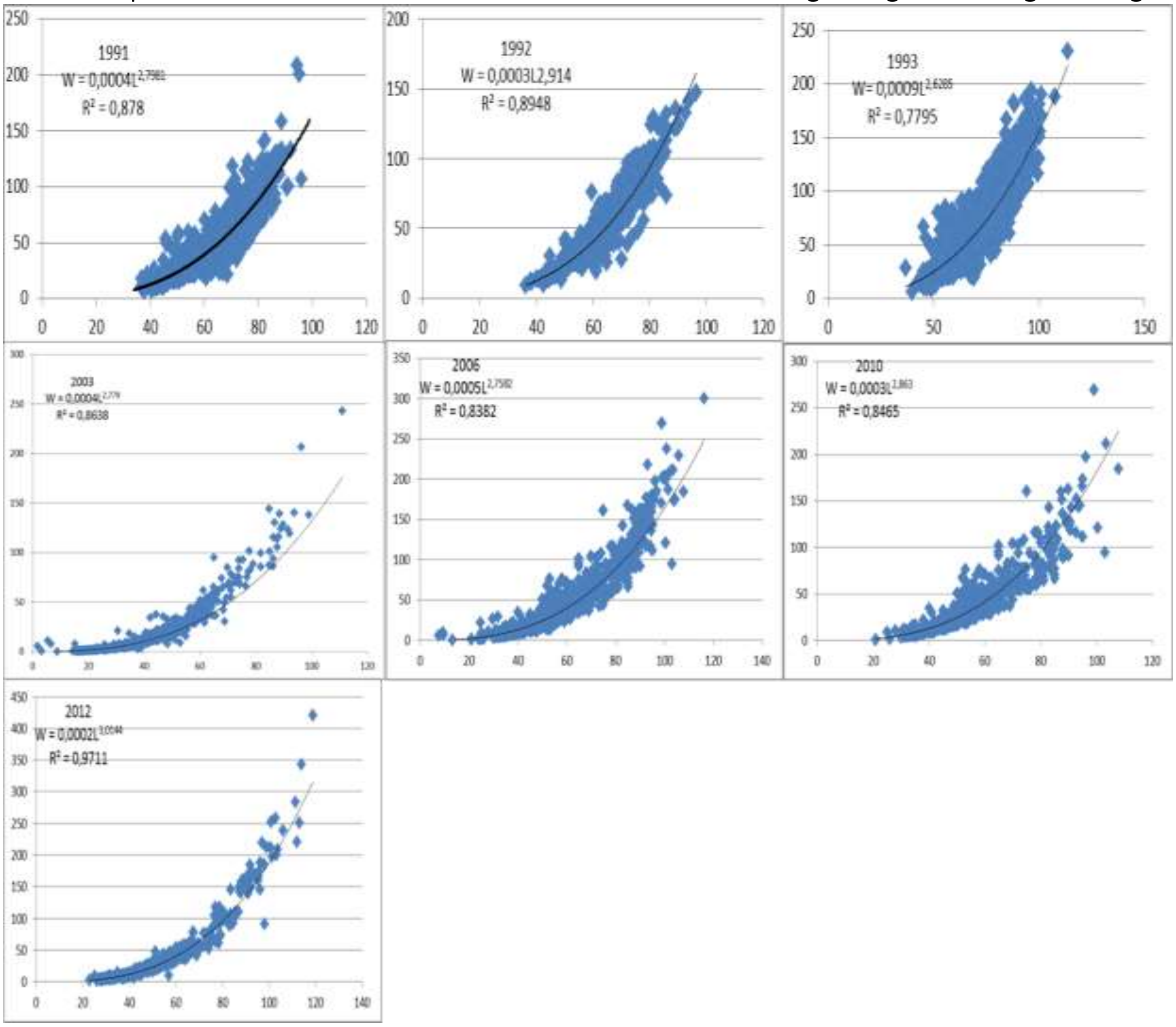


Fig. 6.9.1.2.5. Length weight relationship of Rapana in Turkish Black Sea coast

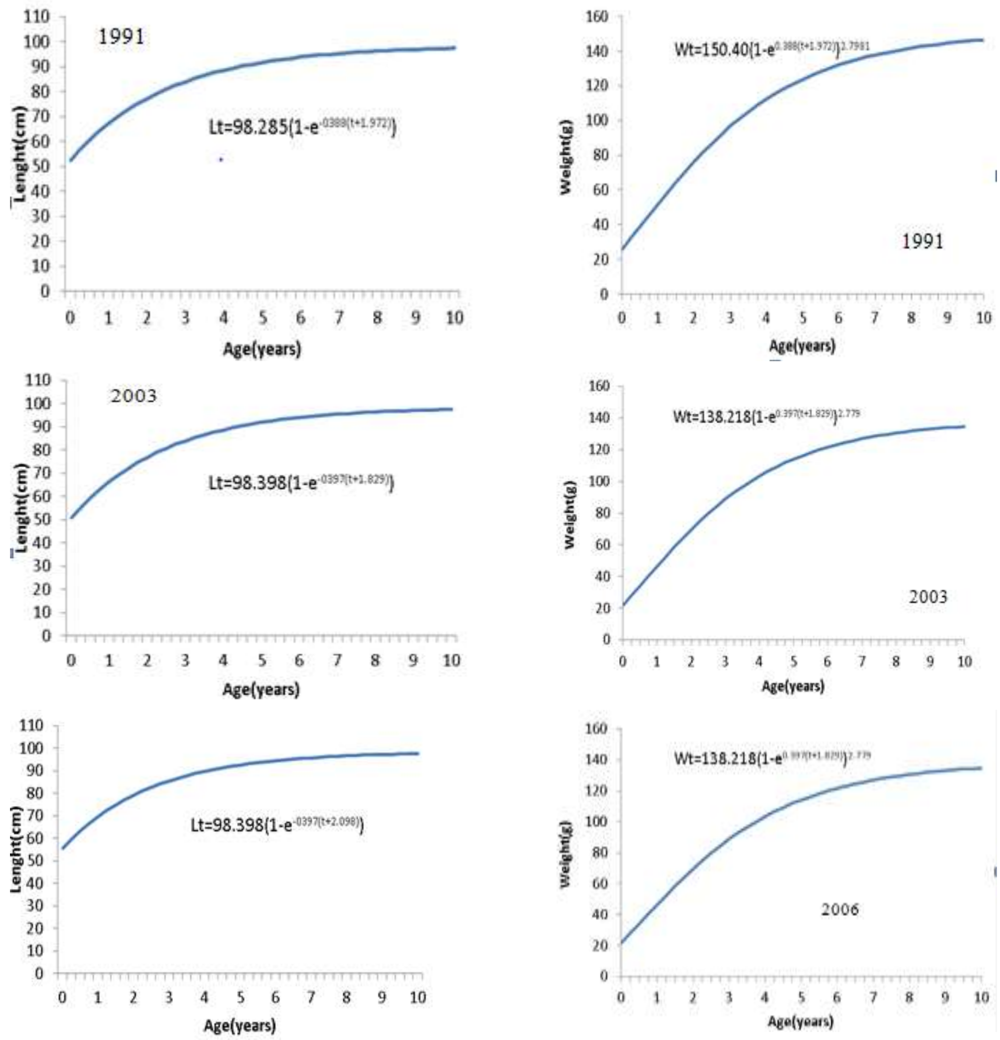


Fig. 6.9.1.2.6 Von Bertalanffy age-length and age-weight relationship of Rapana in the Turkish Black Sea coasts

6.9.1.3. Maturity and Reproduction

The Rapa whelk is dioecious (gonochoristic) with internal fertilization. Internally fertilized eggs are surrounded by a transparent mass of albumin. Egg capsules deposited are covered totally with the female's foot. The capsule size is about 13.3 mm in length. The total number of egg capsules per adult female in the spawning season ranges from 197 to 999 with a mean of 575. On average, each capsule contains 555 eggs. The fecundity from each individual ranges from 106000 to 872000 eggs. Color of egg capsules varies from light yellow to almost black. The light yellow color indicates early embryos and dark brown capsules indicates late veliger larva near hatching. The change in color occurs during larval development (Saglam & Duzgunes, 2007).

Larvae hatch as shelled planktotrophic veligers with a bilobed velum. The mean size of eggs in the capsule is 0.2 mm. The shell length of hatched veliger is about 0.4 mm and has a bi-lobed velum. The intra-capsular veliger development to a free-swimming veliger larva took 22 days at 25ºC (Saglam and Duzgunes, 2007). Similarly, Chukhchin (1984) reports a period of 26 days at 20–22ºC. Whereas Chung et al. (1993) report a 17 d incubation period between egg laying and first hatching at 18.3–20.4ºC in native regions. Saglam et al., (2009) stated that hatching time of veliger larva from egg capsule decreased with increased temperatures in laboratory conditions. Pelagic larvae have a long planktonic phase which may last to a maximum of 80 days. Veliger larvae settle successfully on a wide range of macrofauna including bryozoans and barnacles (ICES, 2004). Rapa whelks migrate from deep water to coastal water to spawn in summer. The female whelks lay masses of egg capsules which they attach to a hard substratum in shallow waters in month of May or early June and spawning continues till August depending on water temperature in the south eastern Black Sea.

The reproductive cycle and larval development of Rapa whelk is well documented (Chung et al., 1993; Chung et al., 2002; Karayucel et al., 2001; Uyan and Aral 2003; Saglam and Duzgunes 2007; Saglam et al., 2009). In its native area Rapa whelk spawns between May and August (Chung et al., 1993), and similar periods have been observed in the introduced range including the Black Sea (Table 6.9.1.3.1).

Table 6.9.1.3.1 Sexual maturity, sex ratio and spawning season of Rapa whelk in native and introduced areas (**imposex female, * normal female)

Reference	Area	Sexual maturity (mm)	Spawning Season	Sex ratio (F: M)
Chukhchin (1984)	Ukraine	58 (35 to 78)	July-September	1:1
Chung et al. (1993)	Korea	33 to 168	May-August	-
Mann et al., (2006)	North America	-	July-September	**:1*
Saglam et al., (2009)	Turkey	40	June-August	1:1.6

The observed sex ratio in late 1990s was 1:1.6 (female: male), mean shell length at sexual maturity was 40 mm; starting from 25-30 mm with a small rate and in 30-35 mm reached %50 and after 40-45 mm size intervals all of the Rapana are mature (Table 6.9.1.3.2). Spawning mainly occurs between June and early August (Sağlam and Duzgunes, 2014) (Figure 6.9.1.3.1). There are some evidences on the variation of sex rates in the population-which was explained first time by imposex. It was first defined by Smith (1971) to describe the imposition of male sexual characteristics in female whelks, that is the female whelk develops a penis and a vas deferens (sperm duct). It can be induced by tributyltin TBT and some other organic trialkyl compounds. The contamination with TBT is possible by water, by sediment or by eating contaminated food (bioaccumulation) (Micu et al., 2009). While imposex development has been observed in gastropods at environmental concentrations of TBT as low as 2 ng l–1(*Nucella lapillus*), the threshold for imposex development in Rapa whelks is still unknown (Mann et al., 2006). According to studies carried out in Romanian coasts Micu at al. (2009) reported that from a total of 134 specimens 11.19% were imposex females, 51.87% males and 36.84 % females.

Table 6.9.1.3.2. Maturity index for size groups

Size groups	Maturity (%)
15-20	0
20-25	0
25-30	10
30-35	50
35-40	75
40-45	100
45-50	100
50-55	100
55-60	100
60-65	100
65-70	100
70-75	100
75-80	100
80-85	100
85-90	100
90-95	100
95-100	100

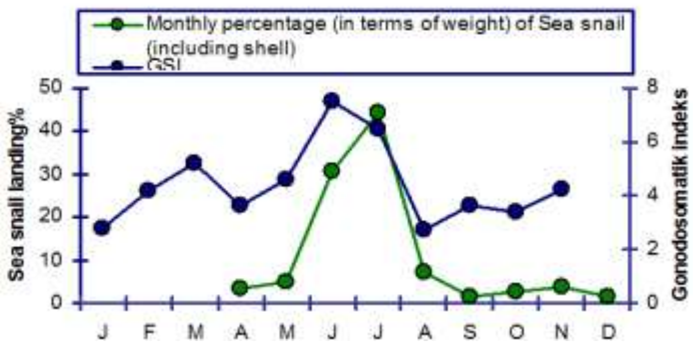


Figure 6.9.1.3.1. The relationship between the monthly landings and the reproduction period GSI of Rapa whelk in Turkey.

100-105	100
105-110	100
110-115	100

Despite the preponderance of imposex females over 'normal' females (by at least a 2:1 ratio), imposex does not appear to compromise reproductive ability of Chesapeake Bay Rapa whelk females (Mann et al., 2006). Micu et al., (2009) found a numerical dominance of males compared to females and a dominance of females compared to imposex females in the Romanian Black Sea.

There are no reported observations of imposex in Rapa whelks in Turkey. But in the other introduced and native populations in USA (Mann et al., 2006), Romania (Micu et al., 2009) and China (An et al., 2013) it has been reported.

Size of egg capsules is about 13.3 mm in length, 1.7–2.5 mm in width and 40 µg in wet weight. The majority of egg capsules (62.8%) are deposited in July, with fewer being laid (deposition) in August (31.9%) and June (5.3%). During the three months of observation, 27 females deposited 182 egg masses and 15,714 egg capsules on the walls of a glass aquaria. The egg capsules were laid in a mass, 1 to 14 times, mostly in 7 batches. The number of egg capsules per egg mass ranged from 3 to 363 with a mean of 84 (N=82). The total number of egg capsules per adult female in the spawning season of different sizes of Rapa whelk ranged from 197 to 999 with a mean of 575. The number of embryos per egg capsule ranged from 124 to 1090. Mean total annual egg production was approximately 3.93×10^5 embryos (Table 6.9.1.3.3) (Saglam and Duzgunes, 2007).

Table 6.9.1.3.3 Egg characteristics of *Rapana venosa*

Parameters	N	Mean	SE	Min	Max
Length of female (mm)	27	63.2	1.5	45.2	78.2
capsules per female	27	575	40.9	197	999
eggs per capsule	365	555	9.8	124	1090
Fecundity (embryos per female)	20	392931	42731	105859	872077
# egg mass laying frequency	27	6.5	0.6	1	14
# egg capsules perr egg mass	182	84	4.8	3	363
Egg diameter µm	100	213.8	21.6	182	276
Egg capsule size mm	382	13.3	0.1	8.7	18.6
Hatching time (day)	1	2	1	15	27

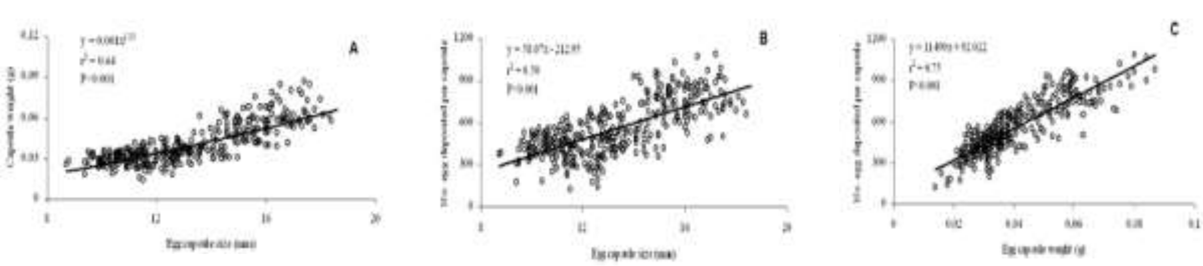


Fig. 6.9.1.3.2 Relationship between (A) egg capsule size and egg capsule weight; (B) the number of eggs deposited per capsule; and (C) egg capsule weight and the number of eggs per egg capsule.

The relationship between capsule length and capsule weight was exponential (Fig. 6.9.1.3.2A); the number of eggs was deposited per capsule and egg capsule size and egg capsule weight were both linear (Fig. 6.9.1.3.2 B and C). Capsule size was strongly correlated with female size (Fig. 6.9.1.3.2 A). Rapa whelk that were 45.2 mm in shell length deposited an average of 388 eggs per capsule, while those that were 71.8 mm in shell length deposited an average of 714 eggs per capsule (Saglam and Duzgunes, 2007).

Analyses of the pooled data set further indicated that the number of eggs initially deposited in each egg capsule increased with female shell length (Fig 6.9.1.3.3 B). The number of egg capsules laid per female was independent of female size (Fig. 6.9.1.3.3 C). The total number of eggs deposited by one female also showed a significant positive correlation with female shell length (Fig. 6.9.1.3.3 D).

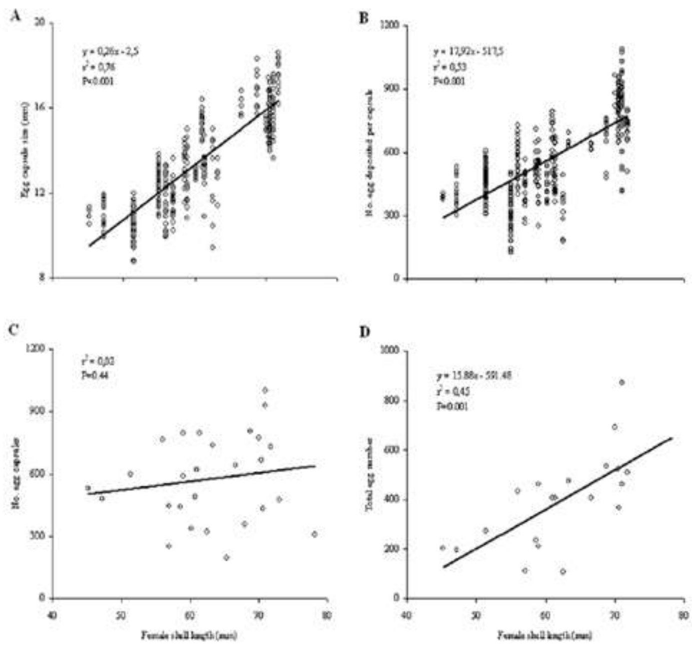


Fig. 6.9.1.3.3 Relationships between (A) female shell length and egg capsule size; (B) the number of capsules deposited; (C) the number of eggs deposited per capsule; and (D) total egg number.

6.9.1.4 Meat Yield

Rapa whelk has a shell rate of 74.5%, net meat rate of 14.2% and a 11.3% of other internal organs (Duzgunes et al., 1988). Mean edible meat yield was calculated as 17.21% (without any other internal organs) in the surveys carried out in the Eastern Black Sea (Duzgunes et al, 1992) but have variations depending on the localities sampled due to food availability in different habitats. Genc (1987) reported that mean meat rate was 24%. The reason of these different rates was estimated as the use of unrepresentative sample sizes and the way of the separation of the meat from other internal organs.

The relationship between dry meat weight (DMW) and wet meat weight (WMW):

DMW=0.1727+O.3049WMW (n=54, r=0.99)

According to the recent studies meat rate (with other internal organs) was calculated as 32% in Trabzon coasts in 2000 and 33% in Samsun coasts in 2012. Samsun area has bigger individuals than the other regions (Fig. 6.9.1.4.1)

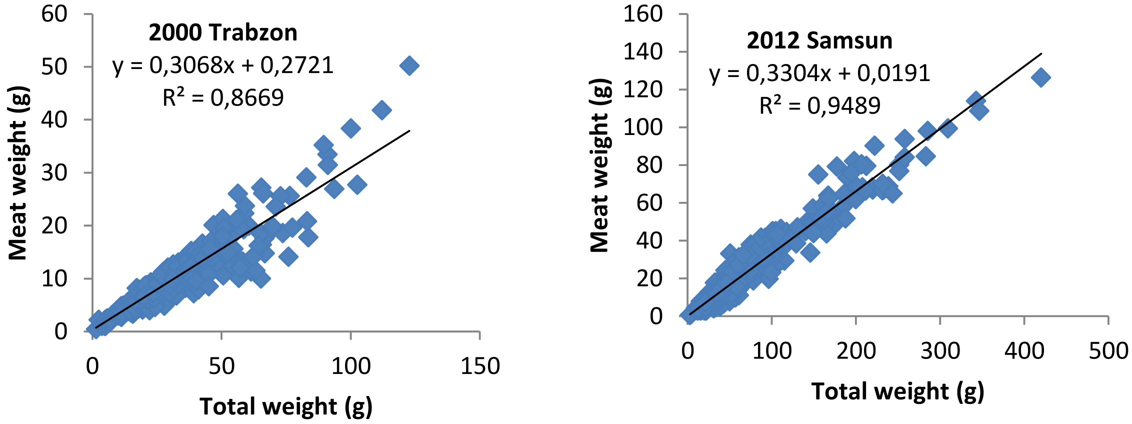


Fig. 6.9.1.4.1 Meat weight versus total weight relationship in 2 different years and locations

6.9.1.5 Feeding

Rapa whelk is a predatory gastropod feeding on bivalves. Due to lack of predators and the population has become very abundant and destructive to native oyster, scallop and mussel populations (Drapkin, 1963; Zolotarev, 1996).

Rapa whelks produce their own toxins for paralyzing their prey (on bivalve species) and eating them with the aid of its soft proboscis (Chukhchin 1984). Small whelks (under 35 mm) feed by drilling through the bivalve shell, whereas large whelks (over 35 mm) can attack and consume bivalves without leaving a drill-hole (Harding et al., 2007).

In laboratory experiments, Rapa whelks remained within burrows for 95% of their time, with just the siphon extended 1-3 cm above the sand and its burrowing behavior expands the potential suite of vulnerable prey items to include infaunal shellfish (e.g., Mya arenaria, Ensis directus, Cyrtopleura costata) (Harding & Mann 1999). In laboratory conditions, adult Rapa whelks consume Mytilus (mussels), Ostrea (oysters), Tapes (clams), Venus (clams), Pecten (scallops), and Cardium (cockles), and the gastropod mollusk Patella (limpets) while young Rapa whelks consume Balanusim provises (barnacle), carrion and the meat of mussels, oysters, dead fish and crabs (Chukhchin 1984). Harding & Mann (2002) stated that once settled onto hard substrates, young Rapa whelks are generalist predators and consume large numbers of barnacles, mussels, oyster spat, and small oysters with whelks reaching shell lengths in excess of 40 mm within 6 months post-settlement.

On average, 50 g of Rapana in the Eastern Black Sea marine ecosystem consume 0.17-0.30 g mussel in a day (Seyhan et al., 2003). In laboratory experiments, small Rapa whelk (60-100 mm) consumed ~3.6% of their body weight with M. mercenaria per day, while large specimens (over 101 mm) ate ~0.8% of their body weight per day (Savini et al. 2002).

Savini and Occhipinti-Ambrogi (2006) reported that when 3 prey types (A. inaequivalvis, T. philippinarum and Mytilus galloprovincialis) were offered to the predator, Rapa whelk showed a preference for Anadara inaequivalvis. When Rapana is offered mussels and oysters simultaneously, it clearly prefers the mussels because of the thinner shell of the mussels. Laboratory observations indicate that Rapa whelk prefer to capture and kill their own food; they will not feed on carrion in the presence of live prey.

The results of feeding experiments in laboratory conditions show that the total time spent for feeding decrease by the increase of size of Rapa whelk. The total time spent for feeding also increases with the increasing prey size (Fig. 6.9.1.5.1) (Sağlam and Duzgunes, 2014). According to the latest study, Rapana (67.5 mm in shell length) ate about 2.5 g mussel tissue in an average of 160 mins (2.7 hr). Due to having no natural predator in the Black Sea, the majority of the mussel and oyster stocks have collapsed while the population size of Rapa whelk has increased.

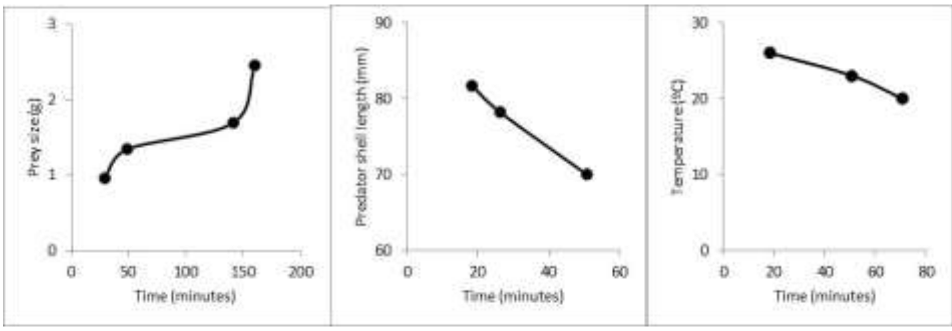


Fig. 6.9.1.5.1 Influence of predator size, prey size and temperature on the total time (± SE) spent on feeding on wet mussel tissue. Time from start of feeding to the end of the meal (mean± SE)(Sağlam and Duzgunes, 2014).

6.9.2 Fisheries

6.9.2.1. General Description

Rapa whelk has become a commercially valuable resource with high demand on the international market. The commercial value of this resource increased initially in Turkey during 1980s and then in Bulgaria (1990s). In Romania, medium-large scale 'subsistence' harvesting is likely to develop into an export-oriented industrial-scale enterprise in the future years. In Ukraine, *R. venosa* catch are limited to local subsistence fishery and souvenir manufacture/trade (Black Sea TDA, 2008; BSC SOE, 2008). The combined annual average of Bulgarian and Turkish exports of frozen Rapana meat during 2003-2010 amounted to about 3000 tons (equal to 18000 tons of catch) and € 13 million annual average export value (two thirds belongs to Turkey) (Knudsen and Zengin, 2012).

Positive economic effects *from R. venosa* fishery are counteracted by negative ecological side-effects of destructive fishing practices used in Turkey and Bulgaria where *R. venosa* is harvested with dredges and beam trawls; in the latter country illegally (Black Sea TDA, 2008). In Bulgaria, Rapana fisheries started in 1994 by method of scuba diving, but later illegal use of beam trawls have been also observed. For that reason, the official landings are misreported to some extent. Due to the fact that the Rapa whelk products are exported the real value of catches could be estimated by official export data. In 2012, use of beam trawls was permitted by the government.

In contrast, in Romania *R. venosa* is selectively fished by SCUBA divers, a sustainable method which does not disturb the habitat or involve by-catches of other animals. However, signs of over-harvesting are already evident in some areas (Black Sea TDA, 2008).

At present dredging, beam trawling and diving are the basic methods used to harvest Rapa whelk in the region, but with different rates in the BS countries. The share of catch by dredges and beam trawls is over 95% in Turkey, 95 % in Bulgaria, 90 % in Ukraine and 74 % in Romania. New attempts were initiated in the recent years in Turkey to use traps and pots instead of destructive dredges (Sahin, 2004; Sağlam, et al., 2007). But the different trap models were found unsatisfactory (financially) and insufficient (catch quantity) by the fishers. These trap models were unfortunately not used in practice, even though they were supported financially during the surveys by Fishery Cooperatives and the Rapa whelk processors in Samsun (Yesilirmak-Kizilırmak) where it has been intensively exploited along Turkish coasts. The fishermen do not use these new gears and prefer to use traditional methods due to lack of incentives by the Ministry.

According to the technical report (Iotov, 2011) prepared for the European Commission, regarding the status of Black Sea fisheries toe date and their future management (presented to the European Parliament) the case of rapa whelk in Black Sea was revised. The report focuses on the importance of research to define the safest fishing techniques for demersal stocks, particularly the veined Rapa whelk. This is of particular importance for the ecosystem of the Black Sea, as it has been revealed that rapa whelk is in the position of ‘a predator without enemy thus exercising great pressure on natural filters of sea waters like blue mussel (*Mytilus galloprovincialis*) and striped venus clam (*Chamelea gallina*) and seriously endangering the ecological balance of the Black Sea.

Though several researche studies from different localities were undertaken on several aspects such as biology, population and ecology of Rapa, still little is known and the present data is lacking any standards as sampling, ageing etc. We have no retrospective data including time-series and the data provided is not sufficient in quantity and quality for a stock assessment model. Furthermore, there is no current study on Rapa considering the parameters required for stock assessment in all the Black Sea countries. If a stock assessment is planned to be run, the first attempt has to be the development of a standardized method for data collection and compilation.

The future work flow for rapa whelk was discussed by the Black Sea EWG and it was concluded to monitor rapa with case studies at least for now and to encourage countries to plan surveys in order to collect new data with a standard methodology required for stock assessment procedures.

6.9.2.2. Management regulations applicable in 2014 and 2015

In Bulgaria, fisheries on Rapana are permitted only by scuba diving method and a license system is also in force. In Ukraine, annual limit for sea snail harvesting up to 400 t has been introduced since 2002.

In Turkey, MFAL implemented some limitations to the fishery of Rapa whelk by yearly circulars which can be mentioned under three items (Table 6.9.2.2.1). The first was the fishing method that permits scuba diving in western part while dredges (mesh size as minimum 40 mm) are allowed in eastern part. The second was about fishing period. Scuba diving was allowed throughout all year but dredges are banned between 1 May and 30 August. In addition, fishing at night was also banned.

The third one is about the area limitations such as closure of a zone 500 m from the coast. Actually, these limitations never came into use and illegal fisheries increased in following years. The possible reasons for illegal fisheries may be considered as:

1. The Rapa whelk migrates to the coastal zone to reproduce in summer months (5-15 m depths) and the illegal fishery increases especially in this period due to abundance and the gear efficiency resulted in higher catches. The Rapa whelk population moves to deep water in autumn when the temperature lowers and so the decrease of the catch in this legal period compels the fisherman to practice illegal activities (Fig. 6.9.2.2.1).

2. The meat yield reaches its highest percentage in summer and market prices get higher. In the legal period (autumn) the condition of Rapa whelk declines. So the processing plants are reluctant to pay highprices.

3. In this legal period the artisanal fishermen harvesting Rapa whelk leave the dredges and focus on bonito fishing which is more profitable.

4. Except the banned period some of the small scale fisherman work as a crew in large vessels (trawls and purse seines). After the closure of the fishing season for the large vessels, they seek a profit from Rapa whelk and fish during the illegal season.

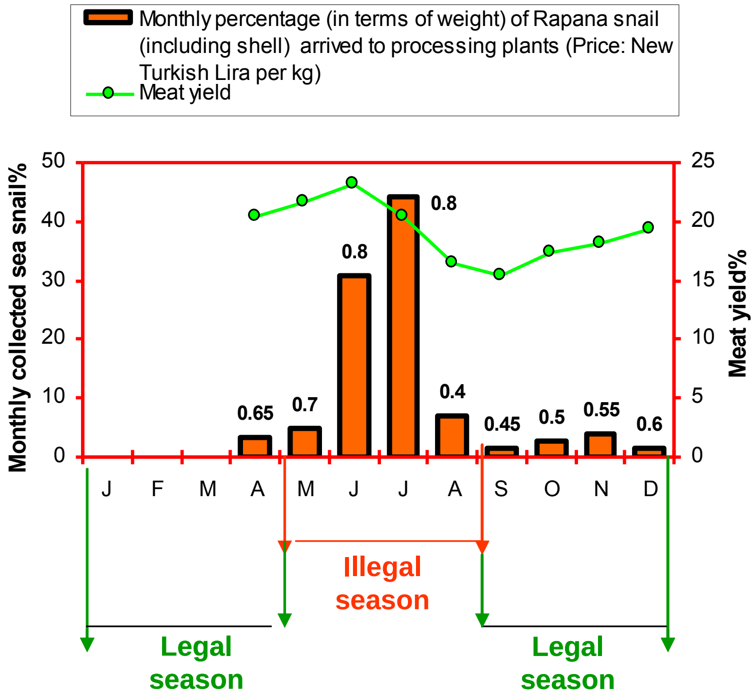


Figure 6.9.2.2.1 The relationship between fishing season, landing, meat yield and price for Turkey (Zengin. 2005).

In Bulgaria the use of all kinds of active fishing gear including bottom gears completely prohibited but the beam trawling is allowed since 2012 (Janssen et al., 2013).

Table 6.9.2.2.1 . Management measures whelk fishery in Turkey (MFAL, 2012)

Type of measure	**Requirements**
Gear restrictions (for dredge)	
Maximum dredge length and height	3 m and 0.4 m
Minimum mesh size in cod-end	72 mm
Maximum cod-end length	1 m
Number of dredge per boat	1
Closed seasons	
Fishing prohibition time for dredge	1 May to 31 August
Fishing time for diving and pots	free all year
Closed areas	
No fishing zones	Marmara Sea, Istanbul Strait and Dardanelles, Izmit Bay
Others restrictions	
The operating time for dredge	between sunrise and sunset
The restriction zone (no fishing distance from the shore)	within 500 m

6.9.2.3 Catches

6.9.2.3.1. Landings

Turkey has been conducting large-scale harvesting of sea snail since the mid -1980s. The Turkish catch remained, however, much higher than other countries followed by Bulgaria (BSC SOE, 2008; GFCM Capture Production 1970-2012; National Fisheries Statistics 2007-2009). Table 6.9.2.3.1.1 and Fig. 6..9.2.3.1.1 show the national and BS total landings.

In Turkey, harvesting of sea snail has been firstly permitted by MARA in 1980’s. The fishery sector expanded including fishermen, commission agents, industrial foundations such as processing plants etc., especially in the Eastern Black Sea. At the beginning, 225 artisanal fishermen were operating with dredges (algarna) along the Eastern Black Sea, but the number of fishermen reached 421 by an increase of 87% in the next ten years (Zengin and Knudsen, 2006). Analysis of fisheries along the eastern coast of Turkey (Samsun Province) showed that number of vessels using dredges for sea snail harvesting in 2000 - 2005 increased in a fast pace, especially in the vessel group 33-149 HP. These are typical boats that combine sea snail dredging, bottom trawling and gill net fishing (Zengin, 2006). Although the resource of this mollusk is still withstanding such high intensity of fisheries, a large-scale implementation of dredges has a destructive effect on the bottom biocenoses and the ecosystems as a whole.

The landings of Rapa whelk in Eastern Black Sea was 10 000 t in 1989, changed around 3 000 tons in average (1- 6 thousand tons) between 1990 and 2000 according to TUIK official data. In the following decade landing of Rapa whelk increased and reached its maximum of 14 000 t in 2004. This trend continued more or less stable (11 000-14 000 tons) until 2009. A sudden decrease was recorded in landings: 6 000 tons in 2009. The increase in 2000 - 2010 may be explained by the depletion of major demersal stocks in the area and a shift of fishermen towards the Rapa whelk fishery for better economic advantages. In 2013, production in all countries increased to the levels as 4819 tons for Bulgaria, 1357 tons for Romania, 8655 tons for Turkey and 586 tons for Ukraine, summing up to 15467 tons for the Black Sea total (Fig. 6.9.1.2.3.1.1, Table 6.9.2.3..1.1).

Until the early 1990s, along the Ukrainian coast the sea snail was harvested in an artisanal way for fine shells used as souvenirs (BSC SOE, 2008). At the same time, the meat of harvested mollusks was thrown away and rarely used as food for animals and more rarely as an exotic food for humans. Along the coasts of Ukraine the densest concentrations of Rapa whelk are found in depths of 3-15 meters along the coast of the Crimea from Mezhvodnoye (the Karkinitsky Bay) to the Cape Takil and in the Kerch Strait. It is in this area of the Black Sea where a specialized harvesting (by Khizhyak's dredge and hand harvesting of divers) for Rapa Whelk has been conducted since 1995 (Shlyakhov V. A.. Mikhaylyuk A. N.. 2010). In the Black Sea the maximum harvesting of Rapa Whelk was observed in 2000 at the level of 913 tons, among which 325 tons were harvested on the ground Cape Takil – Feodosia by 19 groups of harvesters, equipped with aqualungs and using 7 dredges. In the Kerch Strait the maximum harvest of Rapa Whelk reached 49 tons in 2007.

Table 6.9.2.3.1.1 Rapa whelk landings (t) by countries (FAO Fisheries Statistics. GFCM Capture Production 1970 – 2006 and National Fisheries Statistics 2007 - 2013).

	Bulgaria	**Georgia**	**Romania**	**Russian Federation**	**Turkey**	**Ukraine**	**TOTAL**
1983					235		**235**
1984					122		**122**
1985					78		**78**
1986					2030		**2030**
1987					643		**643**
1988					7195		**7195**
1989					9239		**9239**
1990			75		6094		**6169**
1991			70		3738		**3808**
1992			110		3519	14	**3643**
1993			45		3668	3	**3716**
1994	3000				2607	5	**5612**
1995	3120	700			1198	303	**5321**
1996	3260	711			2447	376	**6794**
1997	4900	118			2021	476	**7515**
1998	4300	-			3998	369	**8667**
1999	3800	-			3588	619	**8007**
2000	3800	184			2140	913	**7037**
2001	3353	517			2614	395	**6879**
2002	698	503			6241	91	**7533**
2003	325	295			5500	149	**6269**
2004	2428	65			14034	159	**16686**
2005	511	70			12156	161	**12898**
2006	2773	300			10910	156	**14139**
2007	4310	-			13106	201	**17617**
2008	2872	-			11268	135	**14275**
2009	2214	-	2		6085	190	**8491**
2010	4381	-	0		5460	225	**10066**
2011	-	-	218		7770		**7988**
2012	3793		588		8893	509	**13783**
2013	**4819**		**1357**	**50**	**8655**	**586**	**15467**

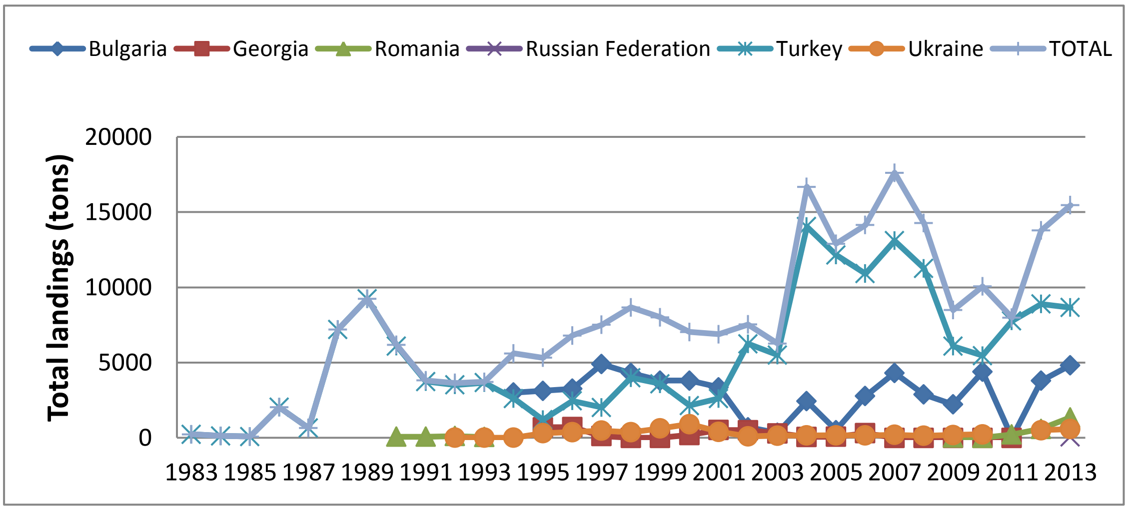


Fig. 6.9.2.3.1.1 Landings of Rapa whelk in the Black Sea countries

After 1983, Rapana stocks have been exploited in Turkey according to the demands of Asian markets, mainly Japan, and processed as frozen meat. Production has reached its maximum about

9500 tons till the period that the main collapse in fisheries occured (1988-89). After a period of recovery, landings of Rapana increased to 14000 tons in 2005. The total catch of Rapana was 8655 tons in Turkey in 2013.

6.9.2.3.2 Discards

Discard quantities are calculated from the rate of individuals smaller than 40 mm in the samples derived from existing length frequency data available for some years. Discard data refers to undersized individuals in the samples and projected to total catch by numbers and weight (Table 6.9.2.3.2.1). It is estimated that discards in 2013 were around 181 tons. Turbot, scorpion fish, horse mackerel, goby fish, sole, ray, seahorse, juvenile gurnard, crabs, mussels, prawns, shrimp and native small whelks are the other species also harvested by dredges as bycatch (Celik & Samsun, 1996; Duzgunes, 2001).

Table 6.9.2.3.2.1 Discard quantities of Rapana in Turkey

Year	Discards (ton)
1991	7.0
1992	2.2
1993	0.9
1994	5.2
1995	
1996	
1997	
1988	
1989	77.9
2000	
2001	
2002	
2003	1292.7
2004	
2005	
2006	150.9
2007	
2008	
2009	
2010	315,4
2011	
2012	316.8
2013	180.6

6.9.2.4 Fishing effort

Rapana fishers in Turkey mostly have vessels between 6-17 m in length. A single dredge is used in vessels smaller than 8 m and the larger ones generally used as pair dredging. Actually, the use of pair dredges is prohibited by national regulations. But fishermen generally use them to obtain more product and they continue fishing also at night, illegally. The number of vessels in Samsun district was 421 by 2005 and nearly half of them (232) had no licenses for Rapa whelk fishing. These vessels intensively operate in inshore benthic areas between depths of 5 and 33 m but mostly around 13 m. Table 6.9.2.4.1 shows the number of vessels having license for Rapana catch in Turkey.

There is no data ono total GT, total operational hours, etc. Romania has 7 vessels operating with dredges in Bulgarian coastal waters.

Table 6.9.2.4.1. Number of licensed vessels for Rapana in Turkey in the Black Sea

Year	Number of vessels
2000	121
2001	116
2002	153
2003	179
2004	495
2005	596
2006	555
2007	504
2008	377
2009	124
2010	239
2011	294
2012	483
2013	580

6.9.2.5 Commercial CPUE

There are some estimates of CPUE based on two assumptions from Rapa whelk fishery in Turkey estimated only for some years using 2 different methods. In the first method, number of vessels provided from MFAL FIS databases from 2000 to 2013 and CPUE is calculated from the landings for relevant years. For prior to 1991, number of vessels were assumed the same as in 2000 (Table 6.9.2.5.1).

Table 6.9.2.5.1 CPUE of Rapana estimated by 2 different methods

Year	No. Vessels	Total catch	CPUE (Catch per vessel)	CPUE (ton /km^2)
1991	121	3738	30.89	4.6
1992	121	3519	29.08	6.0
1993	121	3668	30.31	5.4
1994	121	2607	21.55	
1995	121	1198	9.90	
1996	121	2447	20.22	
1997	121	2021	16.70	
1998	121	3998	33.04	
1999	121	3588	29.65	9.1
2000	121	2140	17.69	
2001	116	2614	22.53	5.4
2002	153	6241	40.79	
2003	179	5500	30.73	0.6
2004	495	14034	28.35	
2005	596	12156	20.40	
2006	555	10910	19.66	1.8
2007	504	13106	26.00	
2008	377	11268	29,89	
2009	124	6085	49,07	
2010	239	5460	22,85	

2011	294	7770	26,43	
2012	483	8893	18,41	
2013	580	8655	14,92	10.1

Maximum CPUE values have been reached in 2002, 2008 and 2009 while the lowest values in 1995 and 2014 (Fig. 6.9.2.5.1).

According to the Bulgarian data, CPUE as kg per h is given in Table 6.9.2.5.2.

Table 6.9.2.5.2 Catch per unit effort (kg/h) of Bulgaria on Rapa whelk fishery by fleet segments in 2008 and 2009.

leet Segment / Average CPU	LOA > 0 < 6		LOA => 6<12		LOA => 12<18		LOA => 18<24		LOA => 24<40	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Rapana RPN	305.69	238.38	461.88	529.95	722.83	611.99	744.84	768.24	no	no

According to the other survey performed in the past by CFRI, the maximum catch was obtained in the summer period by commercial dredges along Samsun in 2005 (Figure 6.9.2.5.2.); catch per unit of dredges in June and July is estimated as 70 and 100.9 kg/hour/vessel. The CPUE decreases in spring and autumn. It reaches ts minimum in spring; 5.7 and 26.3 kg/hour/vessel for April and May, respectively. It is considered to be related to temperature fall and the movement of Rapana to deeper waters. The CPUE increased slightly in autumn and estimated as 57.2 and 40.3 kg/hour/vessel for September and October.

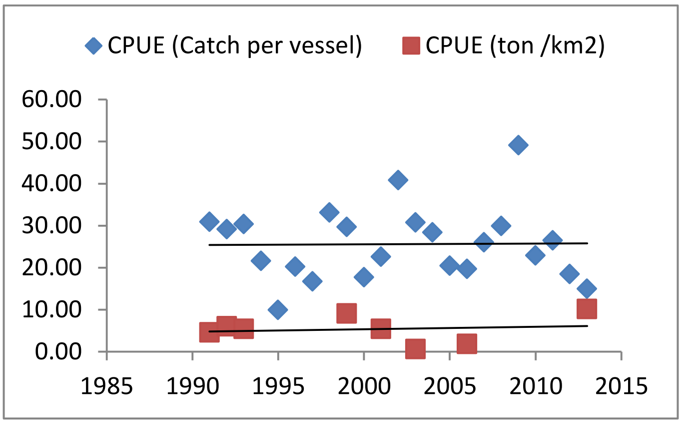


Fig. 6.9.2.5.1 CPUE estimates from commercial catch data

In the previous studies, the CPUE of the dredges operating for rapa fishery from 2005 to 2010 were roughly estimated as 73.1 kg/h, 77.7 kg/h, 70.9 kg/h, 67.4 kg/h, 54.0 kg/h, 67.9 kg/h, respectively. The CPUE values seemed compatible with landings (Fig. 6.9.2.5.2) .

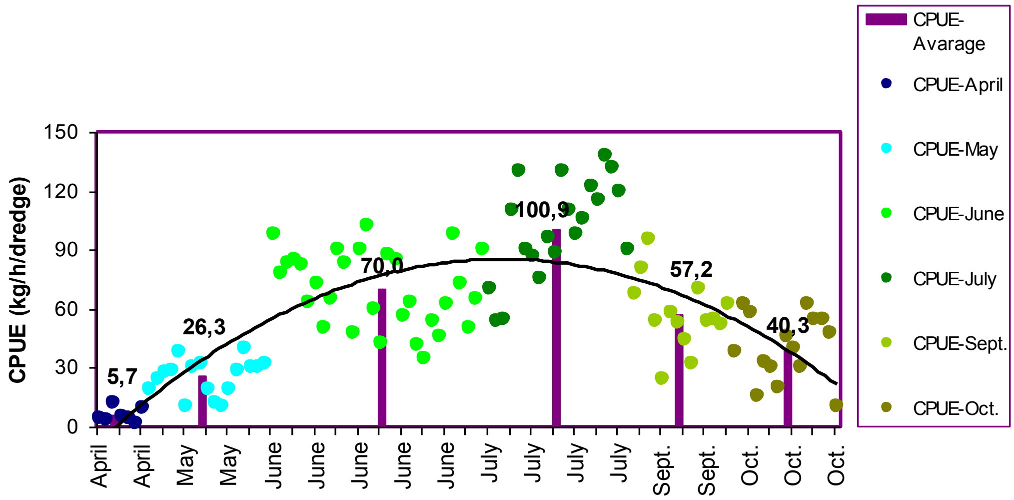


Fig. 6.9.2.5.2 CPUE data obtained from rapa whelk commercial dredges in Samsun coasts for 2005.

The significant increase in Rapa whelk abundance has been observed since 1990 which leads to some ecological problems in near shore benthic communities. The feeding of Rapa whelk on bivalve species as a major source of food creates a high predation pressure that impacts both itself and other demersal species feeding on the same source. The scarcity of food lowers the growth rate of Rapana and prevents it from reaching a harvestable length.

6.9.2.6 Scientific surveys

Though there are several research studies carried out in Turkey most of them are regional and do not provide sufficient data to cover the needs of any kind of assessments. Some of them are presented below:

Survey description	Area covered	Survey design	Survey gear	Years conducted	Survey timing	# stations	Types of data available
Stock assesment[1]	Trabzon, Rize, Giresun	strafied random	dredge	1991-1994	monthly	20	Biometrics, length compositions, whelk weight per tow, sex ratio,
Population dynamic[2]	*Trabzon*	*fixed stations*	*dredge*	*1999*	*monthly*	*2*	*Biometrics, length compositions, whelk weight per tow, sex ratio, gonad weight*
Demersal fisheries survey[3]	*Trabzon*	*strafied random*	*dredge*	*2003*	*seasonally*	*2*	*Biometrics length compositions, whelk weight per tow*
Fisheries[4]	Trabzon, Samsun	fixed stations	dredge	2006	monthly	2	*Biometrics* length compositions, whelk weight per tow, sex ratio,
Population dynamics[5]	Samsun	fixed stations	dredge	2010	monthly	1	shell length, total weight, body weight, length compositions, whelk weight per tow, sex ratio,
Stock assessment[6]	Trabzon, Giresun, Ordu, Samsun, Sinop	*fixed stations*	*dredge*	*2012*	*seasonally*	*5*	*Biometrics length compositions, whelk weight per tow, sex ratio,*
feeding behaviour	Trabzon		laboratory conditions	2000			shell length, total weight, growth type, total time spent feeding

[1]Duzgunes, 1991-94; [2]Saglam, 1999; [3]Zengin, 2003; [4]Saglam, 2006: [5]Sağlam , 2010; [6]Uğur, 2012 ; [7]Saglam and Duzgunes 2012; [8]Sağlam, 2014

There is no monitoring and stock assessment survey program for *Rapana* either in Turkey nor in the other riparian countries. In order to apply an ecosystem approach in the region, *Rapana* population should be monitored every year in order to produce some indices to evaluate the possible changes in the abundance, distribution etc. Establisment of a National Data Collection Program is essential to be supported by scientific surveys.

6.9.2.7 Impact of Rapa fisheries on the Benthic Ecosystem

Invasive species affect our native biodiversity in a number of ways. They may compete directly with native species for food or space, may compete indirectly by changing the food web or physical environment, or may prey on or hybridize with native species. Rare species with limited ranges and restricted habitat requirements are often particularly vulnerable to the influence of these alien invaders.

The introduction of Rapana created a new ecological niche. This brought substantial changes in the biocoenosis of the Black Sea shellfish beds-one dominant species replaced others (Chukchin 1984).

In general, Rapa whelk, as an important predator, usually feeds on bivalves including oysters, mussels and clams, so it is the main reason of the collapse of mussels and oysters in the Black Sea. Chukchin (1984) reports the extinction of the native bivalves *Ostrea edulis* (oysters), *Pecten ponticus* (scallops), *Venus gallina* (clams) and *Mytilus galloprovincialis* (mussels) to predation by *R. venosa* on the Bulgarian coast.

In Rapa whelk dredge fishery, turbot, scorpion fish, horse mackerel, goby fish, sole, ray, sea horse, juvenile gurnard, crabs, mussels, prawns, shrimp and native small whelk were caught as by-catch species (Celik & Samsun, 1996; Duzgunes, 2001).

In some of Asian and American countries whelks harvested by 500 to 1000 baited pots lifted per day and per boat. Pot fishery trials as alternative to dredge in whelk fishery is carried out in the Black sea by several researchers (Unsal et al., 2004; Sahin 2004; Saglam et al., 2008). These studies showed that pot fishery seems not profitable as much as dredging as to cover commercial expectations of the fishermen. If the habitat destruction is considered use of pots and traps are very essential. Experiments with different bait types and pot designs are strongly needed.

Ecosystem effects of fishing should be evaluated based on size and species selection, unaccounted mortality, ghost fishing, habitat effects, energy efficiency, and catch quality. Cochrane & Garcia (2009) stated that ecosystem effect index for pots and beam trawl is 7.3 and 4.6, respectively. Ecosystem effect index (1: non-favorable to 10: favorable) showed that pots are one of the most environmentally friendly fishing methods than beam trawl. Logothesis & Beresoff, (2004) reported that pots are often considered a more beneficial type than dredge because there is less impact on the bottom habitat and by-catch can be at minimum level depending on the design of the pot.

Despite all impacts there are positive effects of the invasive species in socio-economical life of the fishermen communities. In the Black Sea (especially in Turkey and Bulgaria), commercial whelk fisheries have been developed. For artisanal fisheries it is an important income source since two decades. Many whelk fishing vessels, transporters and processing plants provide employment in the region.

Impacts of Rapa whelk on the ecosystem are not well known in the riparian countries due to limited studies concerning the Black Sea ecosystem.

6.9.2.8 Suggestions for better management

Rapa whelk stocks should be monitored and stock abundances need to be assessed continuously (with common methods ie. swept area method) for the sustainable use of the Black Sea resources and in order to better understand the impacts of this invasive species on the Black Sea ecosystem. Normally, STECF interests on exploited stocks focuses on the determination of F_{MSY} and TAC's to support sustainable fishing of the populations. Sustaining the Rapa whelk stock, which is an invasive species that has negative impacts on other species, may not be an appropriate objective for management. If the impact of Rapa whelk is considered, measures taken to protect the *Rapana* population may have dangerous consequences for other species sharing the same habitat. In any case, monitoring is needed to realize the state of the stocks in order to take coordinated measures in the riparian countries. In order to reduce dredge fishery impacts on benthic ecosystem and to support ecosystem based management approach, a stakeholder workshop on management alternatives for the fishery of the Rapa whelk in the Turkish Black Sea coasts was held in 2011 (7^{th} FP Benthis Project) with the participation of all stakeholders. In this workshop the Rapana fishery was evaluated in terms of environmental, socio-economical and implementation of management measures. Finally, seven distinctive management alternatives for Rapa whelk were suggested and examined using multi criteria analysis (MCA) (Janssen et al., 2013). These management alternatives are given below:

a) Business as usual – continuation of the current situation, 10 years from now,
b) Enforcement of dredge ban,
c) Protection of natural habitats,
d) Free access to Rapana fisheries,
e) Compromise solution,
f) Continuity of Rapana fisheries,
g) Continuity of Rapana fisheries with strict enforcement.

After scoring each item and using multi criteria decision analysis, protection of natural habitats (c) was found the best management alternative and the second best was the enforcement of a dredge ban (b) with lower score if environment and social-economic is given highest weight in the analysis. Business as usual has the lowest rank.

If the responsible authorities wish to achieve good environmental and socio-economic results in Rapana fisheries then investments are needed for improved management including funding for research, for strict control and inspection, and subsidizing non-native species control and habitat friendly methods of harvest.

There are some problems involving whelk fishers in these regions. The poor whelk fishers borrow money from the factory owners and then the Rapana are bought from the fishers at lower prices. The unit price of whelk should be determined officially in order to protect the rights of the whelk fishers and encourage them to harvest Rapana. Also, the pot fishery should be encouraged by the government via free distribution of the pots to dredge fishers. Subsidies will be very essential to change the catching method in the region from dredges to less damaging harvesting methods.

Rapa whelk fishing and processing provides employment and foreign currency to the producer nations. Due to its limited domestic consumption the total catch can be easily determined over quantity of exported meat. On the other hand, there is no specific customs tariff number in Turkey (or HS Code) only for Rapa whelk. The real catch data of Rapa whelk can be estimated more precisely from export data by using a new tariff code which is strongly needed.

Rapana invasion is still an ongoing process in the Black Sea. It is very clear that almost all mussel banks, oyster stocks and other bivalve communities are about to collapse due to absence of a predator for Rapana in the Black Sea. All riparian countries should encourage their fishermen to catch Rapana without any size and seasonal limitations using pots and traps. All dredging activities need to be prohibited to protect bottom habitats and biodiversity. Animal feed producer companies and construction companies should be supported and encouraged to use Rapana meat and shells as a raw material. This approach will help reduce the impact of this invasive species on the fragile Black Sea ecosystem.

7. DATA QUALITY AND COMPLETENESS

The data call issued on April 2014 for the Black Sea had a deadline on the 8^{th} of September 2014. Data was uploaded by each country according to the following table:

Table 7.1. Timeline of data upload from Black Sea Mediterranean Member States, data call **deadline of the 8^{th} of September 2014**.

COUNTRY	First Upload	Last Upload
ROM	10 July 2014	03 Sep 2014
BUL	11 Sep 2014	11 Sep 2014

Romania submitted all data in time. Bulgaria has submitted all data after the deadline; JRC identified lack of minimum required information in the Bulgarian submissions and an official request by DG MARE was sent to the Bulgarian national correspondents to deal with this issue.

Data Overview

A summary of the main data gaps is presented below while specific issues related to individual stocks are described in the dedicated chapter under each stock assessment section.

DCF data

Bulgaria (BUL)

- Effort submitted for 2013 is extremely low
- Catch at Age (Table A) and Catch at Length (Table B) data are missing for all species submitted. Only total landings were provided.
- Landings for ANE, MUT, RPW are missing or are questionable
- Survey data for 2013 was not submitted since surveys were not performed.

Romania (ROM)

- TBB- Beam trawl effort is reported for the first time; corresponds to 50% of total fishing effort in Romania

Survey data

Survey data for demersal species is provided in a highly aggregated form for few species. The lack of raw survey data and the scarcity of species reported does not allow to perform stock assessment of new stocks and to explore spatio-temporal trends in the data. The lack of knowledge of how the aggregated survey data is prepared does not allow proper standardization of the tuning indexes within and across countries.

Main issues need to be addressed:

- As a rule, very few species are reported in the submitted data:
  - only 9 species for Romania
  - only 7 species for Bulgaria
- General lack of catch at age or catch at length data for Bulgaria

- It was identified by both Romanian and Bulgarian experts that Data Collection has not yet initiated for 2014 (as of October 2014) and data availability for next years' assessments may be an issue of great concern.
- Raw survey data should be called in the next data call processed by JRC and a common format should be established. A potential database template could be the MEDITS one currently in use in the Mediterranean Sea.

More detailed issues on data quality/coverage can be traced in the detailed assessments section (6)

8. REFERENCES

Abella A., Caddy J.F., Serena F., 1997. Do natural mortality and availability decline with age? An alternative yield paradigm for juvenile fisheries, illustrated by the hake Merluccius merluccius fishery in the Mediterranean. IFREMER Aquatic Living Resources. 10: 257-269.

Abella A., Caddy J.F., Serena F., 1998. Estimation of the parameters of the Caddy reciprocal M-at-age model for the construction of natural mortality vectors. DYNPOP. Genova 2-5.10.96 Cahiers Options Médit 35:191-200

Ak, O., Dağtekin, M. 2014. Horse Mackerel. (E. Duzgunes, B. Ozturk and M. Zengin). Turkish fisheries in the Black Sea. Turkish Marine Research Foundation (TUDAV). Publication number 40. Istanbul, Turkey. pp. 540

Aleev, Y. 1956. On the taxonomy of the Black-Sea scad. Vopr. Ikhtiol. 7, 175-184. (In Russian).

Aleev, Y. 1957. Horse mackerel (Trachurus) of the Soviet seas. Tr.Sevastopol. Biol. St., 9:167-242. (In Russian).

Altukhov, Y. & Salmenkova, E. 1981. Application of the stock concept to fish population in the USSR. Canad. J. Fish Aquat. Sci. 38, 1591-1600.

Altukhov, Yu.P. & Apeken, V.S. 1963. Serological Analysis of the "Small" and "Large" form of the Horse Mackerel in the Black Sea." Vopr. Incthiol., 3, pp. 39-50. (In Russian).

Altukhov, Yu.P. & Michalev, Yu.A. 1964. Differences between the small and large form of the horse mackerel of the Black Sea, established by the characteristics of the cellular thermal stability. Tr. AzTcherNIRO, 22: 23-29. (In Russian).

An LH, Zhang Y, Song SS, Liu Y, Li ZC, Chen H, Zhao XR, Lei K, Gao J, Zheng BH (2013) Imposex effects on the veined rapa whelk (*Rapana venosa*) in Bohai Bay, China. Ecotoxicology 22(3):538-47

Arkhipov, A.G. 1993. Estimation of abundance and peculiarities of distribution of the commercial fishes in the early ontogeny. Vopr. Ichthiol., 33 (4), 511-522. (In Russian).

Atanassov, I., Ivanova, P., Panayotova, M., Tsekov, A., Rusanov, K., 2011. Mitochondrial Control Region D Atanassov, et al. 2011NA Variation Turbot Populations from the Bulgarian and Romanian Black Sea Coasts. Biotechnol. & Biotechnol. Eq. 2011, 25 (3), 1-2305.

Ateş C, Deval MC, Bok T (2008). Age and growth of Atlantic bonito (Sarda sarda Bloch, 1793) in the Sea of Marmara and Black Sea, Turkey. J Appl Ichthyol 24: 546–550

Banarescu, P. & Nalbant, T. 1979. Historique des recherches taxonomiques sur especes et les formes intraspecifique du genre Trachurus – In le chinchard de la mer Noare (*Trachurus mediterraneus ponticus*). Etude monographique, premiere partie. Inst. Romain de recherches marines, Constanta, Romanie, 3-45.

Bektas, Yu. & Belduz, A. 2009. Morphological Variation among Atlantic Horse Mackerel, *Trachurus trachurus* populations from Turkish Coastal Waters. Journal of Animal and Veterinary Advances 8 (3): 511-517.

Bilecik N (1975) La répartition de Rapana thomasiana thomasiana Crosse sur le littoral turc de la Mer Noire s'étandant d'Igneada jusqu'à Calti Burnu. Rapp. Comm. int. Mer Méditerranee 23(2):169-171

Bilecik N. (1990) Deniz Salyangozu *Rapana venosa* (V)'nın Türkiye'nin Karadeniz sahillerindeki dağılımı ve Karadeniz balıkçılığındaki etkisi, TOKB Su Ürünleri Araştırma Enstitüsü Yayını, Bodrum.

Bingel, F., Gügü A. C., Stepnovski A., Niermann U., Mutlu E., Avşar D., Kideyş A. E., Uysal Z., İşmen A.,Genç Y., Okur H., Zengin M., 1995 . Stock assessment study for Turkish Black Sea cost. METU IMS Erdemli and FRI Trabzon, TÜBİTAK, Final Report, 159.

Black Sea TDA, 2008. *www.blacksea-commission.org/_tda2008.*

Cesari P, Mizzan L (1993) Ossevazioni su *Rapana venosa* (Valenciennes, 1846) ta in cattivita (Gastropoda, Muricidae, Thaidinae). Bollettino del Museo Civico di Storia Naturalea di Venezia, 42:9-21.

Chashchin A.K. 1995. Abundance, distribution and migration of the Black Sea Anchovy Stocks. Turkish Journal of Zoology, V. 19, No. 2, pp.173-180.

Chashchin A.K. 1996. The Black Sea populations of anchovy. Scientia marina, 60 (Supl. 2), pp. 219-225.

Chashchin A.K. 1998. The anchovy and other pelagic fish stocks transformations in the Azov-Black Sea basin under environmental and fisheries impact - The Proceedings of the First Int. Symposium on Fisheries and Ecology. 1998. Trabzon/Turkey, pp. 1-10.

Chashchin A.K. 2007. State of Black Sea pelagic fish stocks. In: Int. Scientific and Practical Conference. The Black Sea ecological problems. Collected papers, Odessa: SCSEIO, pp. 369-373. (in Russian).

Chukhchin VD (1984) Ecology of the gastropod molluscs of the Black Sea. Academy of Sciences of the USSR, Kiev Naukova Dumka, 175 pp. (In Russian).

Chung EY, Kim SY, Kim YG. (1993) Reproductive ecology of the purple shell *Rapana venosa* (Gastropoda: Muricidae), with special reference to the reproductive cycle, depositions of egg capsules and hatchings of larvae. *Korean J Malacol* 9:1–15

Chung EY, Kim SY, Park KH, Park GM (2002) Sexual maturation, spawning and deposition of the egg capsules of the female purple shell, *Rapana venosa* (Gastropoda: Muricidae). *Malacologia*, 44: 241–257.

Collette BB, Nauen CE (1983). FAO Species Catalogue Vol. 2. Scombrids of the World. An annotated and illustrated catalogue of tunas, mackerels, bonitos and related species known to date. FAO Fish Synop 2: 53–54

COUNCIL REGULATION (EU) No 1261/2012 of 20 December 2012 fixing for 2013 the fishing opportunities for certain fish stocks and groups of fish stocks applicable in the Black Sea.

DAISIE (2009) European Invasive Alien Species Gateway (http://www.europe-aliens.org/speciesFactsheet.do?speciesId=50553

Dalgıç G, Karayücel S (2006) Investigations on the stocks of the striped venus. Report for the 9th Special Expertise Group for the State Planning Organisation. Turkey

Daskalov, G. 1999. Relating fish recruitment to stock biomass and physical environment in the Black Sea using generalized additive modeling. Fish. Res. 41, 1-23.

Daskalov, G.M., 2002. Overfishing drives a trophic cascade in the Black Sea. MARINE ECOLOGY PROGRESS SERIES Mar Ecol Prog Ser. Vol. 225: 53–63, 2002.

Daskalov G. M. 2003. Long-term changes in fish abundance and environmental indices in the Black Sea. Mar. Ecol. Prog. Ser. 255: 259-270.

Daskalov, G., Rätz, H. J., M., Gümüş, A., Panayotova, M., Raykov, V., M., Zengin, Radu, G., Valodia, M., Shlyakhov, V., 2010. Expert Working Group Report. Assessment of Black Sea Stocks (EWG-11-15). Cadiz, Spain, Scientific, Technical and Economic Committee for Fisheries (STECF) November 2010, European Commission Joint Research Centre Institute for the Protection and Security of the Citizenhttps://stecf.jrc.ec.europa.eu/home, 195 p.

Daskalov, G., Cardinale, M., Charef, A., Duzgunes, E., Genç, Y., Gümüş, A., Maximov, V., Mikhaylyuk, A., Nikolaev, S., Osio, G. C., Panayotova, M., Radu, G., Raykov, V., Shlyakhov, V., Yankova, M. and Zengin, M., STECF members: Casey, J., Abella, J. A., Andersen, J., Bailey, N., Bertignac, M., Cardinale, M., Curtis, H., Daskalov, G., Delaney, A., Döring, R., Garcia Rodriguez, M., Gascuel, D., Graham, N., Gustavsson, T., Jennings, S., Kenny, A., Kirkegaard, E., Kraak, S., Kuikka, S., Malvarosa, L., Martin, P., Motova, A., Murua, H., Nowakowski, P., Prellezo, R., Sala, A., Somarakis, S., Stransky, C., Theret, F., Ulrich, C., Vanhee, W. and Van Oostenbrugge, H., 2012. JRC Scientific and Policy Reports. Scientific, Technical and Economic Committee for Fisheries. Assessment of Black Sea Stocks (STECF-12-15). JRC 76532 , EUR 25580 EN, ISBN 978-92-79-27208-0, ISSN 1831-9424, doi:10.2788/63715

Demir, M. 1957. Migrations of Sarda sarda Bloch in the Marmara and Aegean Seas; The Probable Spawning Places and Time. GFCM Techn. Paper. No: 18, 27 pp

Demir, 1958, Karadeniz Populasyonuna Ait Sarıkuyruk İstavrit Balığı *Trachurus mediterranus* LUTKEN 1880'nin Yumurta ve Larvalarının Morfolojik Hususiyetleri Hakkında, Hidrobiyoloji Mecmuası, Seri A, Cilt IV (3,4) pp. 317-320.

Demir, M. and Demir, N. 1961. Palamut-Torik (Sardasarda Bloch) Yumurtaları Hakkında. Hidrobiyoloji Mecmuası. Seri A, Cilt VI, 1-2

Dincer C.A, Zengin M., Duzgunes.E 2007. A preliminary Study on the small pelagic fish species captured by mid water trawls in the south-eastern Black Sea coasts of Turkey. Journal of Fisheries International 2(1): 104- 109.

Dobrovolov, I., Dobrovolova S. 1983. Biochemical polymorphism of the Black Sea and Mediterranean scads. Proc. of the Institute of Fisheries Varna, XX, 101-107.

Dobrovolov, I., Manolov, Z. 1983. Is the "giant" scad a product of the heterozygotic effect. Fish farm, 1, 11-14. (In Bulgarian).

Dobrovolov, I. 1986. Study of population structure of the Black Sea horse mackerel with gene-markers. Report Anniversary National conference of Biology 29-31 May; Pleven.

Dobrovolov, I. 1988. Biochemical and population -genetic investigations of industrial fish species in the waters of Bulgaria and the World Ocean. Dr.Sc. biol. thesis. Varna 533 p. (In Bulgarian).

Dobrovolov, I. 2000. Genetic divergence between the scad subspecies Trachurus Mediterraneus (Carangidae, Pisces) from the Black Sea and the Mediterranean. Mediterranean Marine Science. Vol. 1/1, 133-139.

Drapkin E (1963) Effect of *Rapana bezoar* Linné (Mollusca, Muricidae) on the Black Sea fauna. Doklady Akademii Nauk SRR, 151(3): 700–703.

Drenski, P. 1948. Composition and distribution of fish in Bulgaria. Annual of Sofia University, Natural Faculty, 44, 3: 11-62.

Drenski, P. 1951. Fish in Bulgaria (Fauna of Bulgaria, № 2). Sofia, 270 p.

Duzgunes E, Karacam H, Seyahan K (1988). Growth and Edible Meat Yield of Sea Snail (Rapana venosa Val. 1846). EU J. of Fisheries (5):19-22.

Duzgunes E, Unsal S, Feyzioglu M (1992) Doğu Karadeniz'deki deniz salyangozu *Rapana thomasiana* Gross, 1861 stoklarının tahmini. Proje no: DEBAG 143/6, KTU Surmene Deniz Bil. Fak., Trabzon, Turkey.

Eremeev, V. and Zuyev, G. 2007. Commercial Fishery Impact on the Modern Black Sea Ecosystem. Turkish Journal of Fisheries and Aquatic Sciences 7: 75-8

FAO (2014). Fisheries and Aquaculture Department, FishStatJ - software for fishery statistical time series, Statistical Query Results for Sarda sarda (Bloch, 1793). Rome, Italy: FAO

Genç, Y., Zengin, M., Başar, S., Tabak, I., Ceylan, N., Çiftci, Y., Ustündağ, C., Akbulut, B., Şahin, T. 1998. The Research Project of Economical Marine Products. TKB, Central Fisheries Research Institute Trabzon, 157 pp.

Genç, Y., 1999, Zengin, M., Başar, S., Tabak, İ., Ceylan, B., Çiftçi, Y., Üstündağ, C., Akbulut. B., Şahin,T., 1999, Ekonomik Deniz Ürünleri Araştırma Projesi, Proje No: TAGEM/IY/96/17/3/001, Sonuç Raporu, TKB Su Ürünleri Merkez Araştırma Enstitüsü, 157 s, Trabzon.

Genç Y., Ak, O., Başçınar N.S., Dagtekin M., Atılgan E., Erbay M., Akpınar İ. Ö. 2011, Purse seine fisheries monitoring Project, Central Fisheries Research Institute, Trabzon, Turkey.

Genç Y., Ak, O., Başçınar N.S., Dagtekin M., Atılgan E., Erbay M., Akpınar İ. Ö., 2014. "Purse seine fisheries monitoring project", TAGEM/HAYSÜD/2006/09/02/02, Project Raport, Central Fisheries Research Institute, Trabzon, Turkey.

Georgiev, Z., Kolarov, P. 1959. Abs. Bulletin of Bulgarian Academy of Sciences.

Georgiev, Z. & Kolarov, P. 1962. On the migration and distribution of horse mackerel (*Trachurus ponticus*, Aleev) in the western part of Black Sea. Arbeiten des Zentralen Forschungsinstitutes fur Fishzught und Fisheries –Varna, II, 148-172 p. (In Bulgarian).

Giberto DA, Schiariti A, Bemec CS (2011) Diet and daily consumption rates of *Rapana venosa* (Valenciennes, 1846) (Gastropoda: Muricidae) from the Rio de la Plata (Argentina-Uruguay). J Shellfish Research 30(2): 349-358

Golovko, N. 1964. Electrophoretic investigations of serum proteins of the "giant" and "small" scad in the Black Sea. Tr. Azov-Chernomor. Res. Inst. Fisheries 22, 73-94.(In Russian).

Grishin, A., Daskalov, G., Shlyakhov, V., Mihneva, V. 2007. Influence of gelatinous zooplankton on fish stocks in the Black Sea: analysis of biological time-series. Marine Ecological Journal, 6(2), Sevastopol, 5-24.

Harding JM, Kingsley-Smith P, Savini D, Mann R (2007) Comparison of predation signatures left by Atlantic oyster drills (Urosalpinx cinerea Say, Muricidae) and veined rapa whelks (*Rapana venosa* Valenciennes, Muricidae) in bivalve prey. Journal of Experimental Marine Biology and Ecology 352: 1-11.

Harding JM, Mann R (1999) Observations on the biology of the veined Rapa whelk, Rapana venosa (Valenciennes, 1846) in the Chesapeake Bay. Journal of Shellfish Research, 18: 9–17.

Harding JM, Mann R (2002) Early life history tactics of veined rapa whelks (*Rapana* venosa) in Chesapeake Bay: Blueprint for a successful bioinvasion by stealth. 11th International Conference on Aquatic Invasive Species, Washington D.C., February 23-27, 2002.

ICES (2004) Alien species alert: *Rapana venosa* (veined whelk). Mann R, Occhipinti A, Harding JM (eds) ICES Cooperative Research Report No. 264:14 s.

Ivanov, Karapetkova, 1979; Dynamics of the Reserve of Turbot (Scophthalmus maeoticus(Pallas) in the Bulgarian Shelf of the Black Sea and measures for their Rational Utulisation. II Reserves and Reproduction. Hydrobiology, BAS, vol.9, 3-27 pp.

Ivanov L.S. and Beverton R.J.H., 1985. The fisheries resources of the Mediterranean. Part two: Black Sea. FAO Studies and Reviews, 60:135 pp.

Ivanova, P. P., Dobrovolov, I. S., Bat, L., Kideys, A. E., Nikolsky, V. N., Yuneva, T. V., . . . Shulman, G. E. (2013). Application of Esterase Polymorphism to Specify Population Genetic Structure of Engraulis encrasicolus (Pisces: Engraulidae) in the Black and Azov Seas. *Marine Ecological Journal, 12 (4)*, 45 - 52.

Janssen R, Knudsen S, Todorova V, Gündüz HA (2013) Managing Rapana in the Black Sea: Stakeholder workshops on both sides. Ocean & Coastal Management (in press)

Karayucel S, Kalma M, Karayücel I, Baki B (2001) Deniz salyangozunun (Rapana venosa Valenciennes, 1846) Sinop yöresinde mevsimsel göçleri, yumurtlama zamanı ve yumurta verimi üzerine bir araştırma. O.M.Ü. Ziraat Fakültesi Dergisi. 16 (3):1-4.

Karpetkova, M., 1964. On the Distribution and Migration of the Turbot Along the Bulgarian Coast of the Black Sea. Izv. Zool. Inst. Bulg. Akad. Nauk. 16: 61-85.

Karapetkova, M., Zhivkov, M. 2006. The fishes of Bulgaria. (In Bulgarian).

Kayalı, E. 1998. "The determination of population parameters and reproduction characteristics of horse mackerel (*Trachurus mediterraneus* Steindchner, 1868) and anchovy (*Engraulis encrasicolus* Linnea, 1758) caught in the Eastren Black Sea", KTÜ, Institute of Science , Master Thesis, 238 pp. (in Turkish)

Kell, L. T., Mosqueira, I., Grosjean, P., Fromentin, J-M., Garcia, D., Hillary, R., Jardim, E., Mardle, S., Pastoors, M. A., Poos, J. J., Scott, F., and Scott, R. D. 2007. FLR: an open-source framework for the evaluation and development of management strategies. – ICES Journal of Marine Science, 64: 640–646.

Knudsen S., Zengin M (2006) Multidisciplinary Modelling of Black Sea Fisheries: A Case Study From Samsun. Turkey. Black Sea Ecosystem 2005 and Beyond, 1st Biannual Scientific Conference, BSERP/BSC, 8-10 May 2006 İstanbul, Turkey

Knudsen S., Zengin M (2012) Non –indigenous and commercial resource: The Rapana management dilemma in the Black Sea. Personal communication)

Majorova A, Tkacheva KS (1959). Distribution and conditions of reproduction of pelamid, Sarda sarda (Bloch), in the Black Sea according to data for the period 1956–1957. Proc Tech Pap GFCM 5: 509–514

Mann R, Harding JM, Westcott E (2006) Occurrence of imposex and seasonal patterns of gametogenesis in the invading veined rapa whelk *Rapana venosa* from Chesapeake Bay, USA. Marine Ecology Progress Series 310: 129–138

Maximov V., G. Radu, I. Staicu, 2006. Contributios to the knowledge of the biological caracteristics of the some demersal fish from the Romanian marine area. Cercetari Marine (Recherches Marines), v. 36, p. 153-172.

Maximov V., S. Nicolaev, G. Radu, I. Staicu, 2008. Estimation of growing parameters for main demersal fish species in the Romanian Marine Area. Cercetări marine, (Recherches Marines), 37:p. 289-304.

Maximov V.,, I. Staicu, 2008. Evolution of Demersal Fish Species catches from the Romanian Marine Area between 2000 and 2007; Cercetări marine (Recherches Marines), v. 37:305-323.

Maximov V., E. Patras, L. Oprea, G. Radu T. Zaharia, 2010. Contributions to the knowledge of the biological characteristcs of the main marketable fish species from the Black Sea Romanian area, between 2005-2009; International Conference on Fishery and Aquaculture „A view point upon the sustainable management of the water resources in the Balkan Area", Galati, Romania, 2010 (in print JEPE);

Maximov V., S. Nicolaev, G. Radu, T. Zaharia, G.M. Popescu, 2010. The sustainable management of the turbot Psetta maxima maeotica L., resources an the Romanian Black Sea littoral; Simposionul Internaţional Protecţia şi Gestionarea Durabilă a ecosistemului Mării Negre, Imperativ al Mileniului trei, Ediţia a IV-a, I.N.C.D.M. "Grigore Antipa", 29-30 octombrie 2009, Constanta, România (in print - Cercetări marine / Recherches Marines, nr. 39).

Maximov V., T. Zaharia, S. Nicolaev, 2010. State of the fisheries, stock assessment and management of the black sea tourbot (Psetta maxima maeotica p.) in Romania: International Conference on Fishery and Aquaculture „A view point upon the sustainable management of the water resources in the Balkan Area", Galati, Romania, 2010 (in print JEPE);

Maximov V.,, G. Radu, E. AntonE, T. Zaharia, 2010. Evolution analysis of the fishing and of the biological characteristics of the main fish species from the romanian pontic basin area, during the period 2000 – 2008; Simposionul Internaţional Protecţia şi Gestionarea Durabilă a ecosistemului Mării Negre, Imperativ al Mileniului trei, Ediţia a IV-a, I.N.C.D.M. "Grigore Antipa", 29-30 octombrie 2009, Constanta, România (in print - Cercetări marine / Recherches Marines, nr. 39);

Maximov V., G. Radu, I. Staicu, E. Anton, 2009. Assessment study of turbot stocks (Psetta maxima maeotica) on Romanian Black Sea coast area; NAFA Bucharest / JRC/STECF-UE / DG MARE, 46.

Micu S, Comanescu G, Kelemen B (2009) The imposex status in Rapana venosa population from agigea littoral. Analele Științifice ale Universității „Al. I. Cuza" Iași, s. Biologie

Nikolov DK (1960). Biology of the bonito Sarda sarda (Bloch) from the Black Sea. Trud Nauch-issled. Inst Rib Prom Varna 3: 91–115 (in Bulgarian).

Nikolsky, G.W. 1957. Spezielle Fischkunde, VEB Deutscher Verlag der Wissenschaften, Berlin

Numann W (1955). Die Pelamiden (Sarda sarda) des Schwarzen Meeres, des Bosporus, der Marmara und der Dardanellen

Nümann, W. 1954. Coralance et Migrations des Pelamides (Sarda sarda) Dans les Eaux de la Turqie. CGPM Documents de Travail, 3, Reunion. Doc. 42 pp.

Nümann, W. 1956. Biologische Untersuchungen uber die Stocker des Bosphorus, des Schwarzen Meeres und der Marmara. Istanbul University (B) 4:1.

Panayotova M., V. Todorova, Ts. Konsulova, 2006. Assessment of the Black Sea turbot (Psetta maxima) stock along the Bulgarian Black Sea coast by swept area method. Project report for the National Agensy of Fisheries and Aquaculture, 38 pp.

Panayotova M., V. Todorova, Ts. Konsulova, V. Raykov, M. Yankova, E. Petrova, Stoykov, 2007a. Species composition, distribution and stocks of demersal fish species along the Bulgarian Black Sea coast in 2006. Project report for the National Agency of Fisheries and Aquaculture, 71 pp.

Panayotova M., V. Todorova, Ts. Konsulova, V. Raykov, M. Yankova, E. Petrova, Stoykov, 2007b. „Turbot stock assessment (Psetta maxima) by swept area method in front of Bulgarian Black Sea coast during spring 2007". Project report for the National Agency of Fisheries and Aquaculture.

Panayotova M., V. Todorova, Ts. Konsulova, V.Raykov, 2008a. Stock Assessment of Turbot (Psetta maxima) by Swept Area Method during the autumn season of 2007 along the Bulgarian Black Sea coast. Scientific report, 2008.

Panayotova M., V. Todorova, Ts. Konsulova, V.Raykov, 2008b. Stock Assessment of Turbot (Psetta maxima) by Swept Area Method during the spring season of 2008 along the Bulgarian Black Sea coast. Scientific report, 2008.

Panayotova M., V. Todorova, Ts. Konsulova, V.Raykov, 2009. Stock Assessment of Turbot (Psetta maxima) by Swept Area Method during the spring season of 2009 along the Bulgarian Black Sea coast. Scientific report, 2009.

Panayotova M., V. Todorova, Ts. Konsulova, V.Raykov, 2010. Stock Assessment of Turbot (Psetta maxima) by Swept Area Method during the autumn-winter season of 2009 along the Bulgarian Black Sea coast. Scientific report, 2010.

Panayotova M., V. Raykov, V. Maximov, Gh. Radu, E. Anton, 2012. Distribution, abundance and population structure of Turbot (Psetta maxima L.) in the Bulgarian and Romanian Black Sea area in spring 2010. Compt. rend. Acad. bulg. Sci., Tome 65, vol.1, 63-66 pp.

Panayotova M., V. Raykov, V.Todorova, 2012. Turbot (Psetta maxima L.) abundance indices and stock dynamics off Bulgarian Black Sea coast during the period 2006 - 2009. Acta Zool. Bulg., 64 (1), 85-91 pp.

Panayotova M., V.Raykov, 2012. Scientific report of International Bottom Trawl Survey in the Black Sea (Bulgarian area) in June 2011 to National Agency of Fisheries and Aquaculture of Bulgaria in relation to National Data Collection program for 2011, 38 pp.

Panayotova M., V.Raykov, 2012. Scientific report of International Bottom Trawl Survey in the Black Sea (Bulgarian area) in October - November 2011 to National Agency of Fisheries and Aquaculture of Bulgaria in relation to National Data Collection program for 2011, 40 pp.

Panayotova M., V.Raykov, 2013. Scientific report of International Bottom Trawl Survey in the Black Sea (Bulgarian area) in May 2012 to National Agency of Fisheries and Aquaculture of Bulgaria in relation to National Data Collection program for 2012.

Popova, V.P., 1954. On the Distribution of the Turbot in the Black Sea. Tr. Vees. Nauchna, Issled. Inst. Morsk. Rbyon. Khoz. Okeqn. Ogr., 28: 151-9.

Prodanov K, Konsulova T, Todorova V (1995) Growth rate of *Rapana thomasiana* along the Bulgarian Black Sea Coast. Rapp.Comm.Int.Mer.Medit, 34, Congress of CIESM

Prodanov K, Konsulova T. (1995) 1993 *Rapana thomasiana* stock assessment and catch projection along the Bulgarian Black Sea coast. Rapp.Comm.Int.Mer.Medit., 34, Congress of CIESM, Malta

Prodanov, K., K. Mikhaylov, G. Daskalov, K. Maxim, E. Ozdamar, V. Shlyakhov, A. Chashchin, A. Arkhipov, 1997. Environmental management of fish resources in the Black Sea and their rational exploitation. Studies and Reviews. GFCM. 68. Rome, FAO . 178p.

Radu G., E. Anton, Mariana Golumbeanu, 2010 - State of the Romanian Black Sea Fisheries in the Last Decade. International Conference on Fishery and Aquaculture - A View Point Upon the Sustainable Management of the Water Resources in the Balkan Area. 26-28 May, 2010, Galati – ROMANIA ISSN: 1311-5065.

Radu G., E. Anton, Mariana Golumbeanu, V. Raykov, Maria Yankova, Marina Panayotova, V. Shlyahov, M. Zengin, 2010 - Evolution and state of the main Black Sea commercial fish species correlated with ecological conditions and fishing effort. Journal of Ecology and Environmental Protection – JEPE, (in press). 2010.

Radu G., E. Anton, Mariana Golumbeanu, V. Raykov, Maria Yankova, Marina Panayotova, V. Shlyahov, M. Zengin, 2010 - Evolution and State of the Main Black Sea Commercial Fish Species Correlated with Ecological Conditions and Fishing Effort. International Conference on Fishery and Aquaculture - A View Point Upon the Sustainable Management of the Water Resources in the Balkan Area. 26-28 May, 2010, Galati – ROMANIA. ISSN: 1311-5065.

Radu G., E. Anton, Mariana Golumbeanu, V. Raykov, Maria Yankova, Marina Panayotova, 2010 - Sprat (Sprattus Sprattus L., 1758) and Turbot (Psetta Maxima Maeotica Pallas, 1814) Stocks in the Bulgarian and Romanian Black Sea Area. International Conference on Fishery and Aquaculture - A View Point Upon the Sustainable Management of the Water Resources in the Balkan Area. 26-28 May, 2010, Galati – ROMANIA, ISSN: 1311-5065.Raykov V. , Schlyakhov Vl , Maximov ,V. , Radu, Gh. , Staicu, I. , Panayotova, M , Yankova, M , Bikarska I. 2008. Limit and target reference points for rational exploitation of the turbot (Psetta maxima L.) and whiting (Merlangius merlangus euxinus Nordm.) in the western part of the Black Sea.VI Anniversary Conferense of the Institute of zoology.Acta Zoologica Bulgarica, Suppl.2,305-316.

Radu G., S. Nicolaev, 2010 - The regulation of Black Sea fish stocks. International Association for Danube Research- IAD Danube News 22-5. Editor DANUBE NEWS Alumnus: Swiss Federal Institute of Aquatic Science and Technology (Eawag), Ueberlandstrasse 133; CH-8600 Dübendorf, Switzerland (in press).

Radu G., S.Nicolaev, E.Anton, Maria Yankova, Marina Panayotova, V. Raykov, 2010 - Sprat and Turbot Fisheries in the Bulgarian and Romanian Black Sea Area. Cercetari G. Radu, S. Nicolaev, Elena Radu, E. Anton, 2010 - Romanian Marine Fisheries as a Reflection of the Ecological Conditions of the Black Sea. Acta Ichtiologica Romanica, 2010 (in press).

Radu, Gh., Radu, E. 2008. Determinator al principalelor specii de pesti din Marea Neagra. Editura VIROM, Constanta, 558 p. (In Romanian).

Raykov, V., Yankova, M. 2008. Growth dynamics and mortality estimation of the Horse Mackerel (*Trachurus mediterraneus ponticus*, Aleev) migrating along the Bulgarian Black Sea Coast. Proceedings of first Biannual Scientific Conference "Black Sea Ecosystem and Beyond" 8-10 May 2005, Istanbul, 882-894.

Revina, N.I. 1964. Biological research of the Black Sea and its fishing resources. On provision of anchovy and horse mackerel larvae with feed in the Black Sea. Proceedings of AzCherNIRO, Kerch, 23, 105-114. (In Russian).

Rey JC, Alot E, Ramos A (1986). Growth of the Atlantic bonito (Sarda sarda Bloch, 1793) in the Atlantic and Mediterranean area of the Strait of Gibraltar. Inv Pesq 50: 179–185 Hidrobiology 3: 75–127 (in German).

Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations, Bull. Fish. Res., Board. Can., 191, 382 p.

Sabatella E., R. Franquesa, 2004. Manual for fisheries sampling surveys: Methodologies for estimation of socio-economic indicators in the Mediterranean sea. General Fisheries Commission for the Mediterranean. Studies and Reviews, No.73, FAO Rome, ISBN 1020-7236, 38 pp.

Sabatés A, Recasens L (2001). Seasonal distribution and spawning of small tunas, Auxis rochei (Risso) and Sarda sarda (Bloch) in the northwestern Mediterranean. Sci Mar 65: 95–100.TUIK, 2013

Saglam H, Duzgunes E, Ogut H (2009) Reproductive ecology of the invasive whelk *Rapana venosa* Valenciennes, 1846, in the southeastern Black Sea (Gastropoda: Muricidae), ICES Journal of Marine Science, 66: 1865-1867.

Saglam H, Duzgunes E (2007) Deposition of egg capsule and larval development of Rapana venosa (Gastropoda: Muricidae) from the south-eastern Black Sea. JMBA UK, 87: 953-957.

Saglam H, Duzgunes E (2014) Biological parameters and feeding behaviour of invasive Rapa whelk Rapana venosa Valenciennes, 1846 in the south-eastern Black Sea.J.Coastal life Medicine. 2(6):442-446.

Saglam H, Kutlu S, Bascinar S, Dagtekin M, Selen H. Sahin A (2008) Deniz Salyangozu Avcılığında Direce Alternatif Farklı Tuzak Modellerinin Geliştirilmesi. Proje no: TAGEM/HAYSÜD/2005/09/02/02. Su Ürünleri Merkez Araştırma Enstitüsü, Trabzon.

Saglam H, Özdemir G, Ceylan B, Haşimoğlu A, Özdemir A (2009) Doğu Karadeniz'de istilacı deniz salyangozunun, *Rapana venosa* Valenciennes 1846, veliger larvalarının gelişimi, XV. Ulusal Su Ürünleri Sempozyumu, "Ekosistem Yaklaşımlı Su Ürünleri Üretimi" 1-4 Temmuz 2009 Rize.

Saglam H (2003) Doğu Karadeniz'deki deniz salyangozunun *Rapana thomasiana* Crosse, 1861 Biyoekolojisi. Doktora tezi Trabzon 101 s.

Sağlam H., Duzgunes E (2014) Rapa whelk (*Rapana venosa* Valenciennes, 1846) Fisheries in the Black Sea. Turkish Fisheries in the Black Sea. 361-395p. Edited by Duzgunes E., Öztürk B. and Zengin M. Published by TUDAV, publication no:40, Istanbul, TURKEY

Sağlam, NE, Sağlam C, Sağlam YD (2014) Determination of some population parameters of the veined rapa whelk (*Rapana venosa*) in the Central Black Sea. JMBA UK DOI: http://dx.doi.org/10.1017/S0025315414000885 7 pages.

Sağlam H., Duzgunes E (2014) Rapa Whelk (Rapana venosa Valenciennes, 1846) Fisheries in the Black Sea Pp. 305 – 339. In. E. Duzgunes, B. Ozturk and M. Zengin (Eds). Turkish fisheries in the Black Sea. Turkish Marine Research Foundation (TUDAV). Pub. No:40. Istanbul, Turkey. 504 p

Sahin A (2004) Deniz salyangozu avcılığında tuzak ve sepetlerin kullanım olanakları, KTÜ Fen Bilimleri Enstitüsü Yüksek Lisans tezi, Trabzon 64s

Savini D, Harding, JM, Mann R (2002) Rapa whelk *Rapana venosa* (Valenciennes, 1846) predation rates on hard clams *Mercenaria mercenaria* (Linnaeus, 1758). Journal of Shellfish Research, 21: 777–779.

Savini D, Occhipinti Ambrogi A (2006) Consumption rates and prey preference of the invasive gastropod *Rapana venosa* in the northern Adriatic Sea. Helgoland Marine Research 60:153–159.

Scientific, Technical and Economic Committee for Fisheries (STECF) – 2013 Assessment of Black Sea stocks (STECF 13-20), 2013. Publications Office of the European Union, Luxembourg, EUR 25309 EN, JRC 85367, 429 pp.

Seyhan K, Evren R, Emiral H, Engin S, Demirhan S (2003) Diel feeding periodicity, gastric emptying and estimated daily food consumption of whelk (*Rapana venosa*) in the south eastern Black Sea (Turkey) marine ecosystem. Indian Journal of Marine Science, 32:249-251.

Shaverdov, R.S. 1964. On the interrelations between the giant and small scads in the Black Sea. Vopr. Ikhtiol. 4, 82-91. (In Russian).

Shlyakhov, V. A., Grishin A. 2009. N. The state of plankton cenosis and fishing of pelagic fish in the Black Sea after the introduction of Ctenophores *Mnemiopsis leidyi* and *Beroe ovata*. – Fish industry of Ukraine, No. 5. – P. 53-61. (in Russian).

Shlyakhov, V. A., Mikhaylyuk A. N., Bondarenko I. V., Evchenko O. V., Ershova O. V., Korkosh V. V., Merzlikin V. L., Chashchin A. K.., Shlyakhova O. V. 2012. Fishery and biological indices of Ukrainian fishery in the Black Sea in 2002-2011. – The collection of works of YugNIRO, vol. 50, 2012. – P. 12-29. (in Russian).

Shlyakhov et al. 2013. Forecast of stock and possible removal of water bioresources the Black Sea, Kerch Strait, and Marine Migratory Fish Stocks in 2015. YugNIRO, Kerch, 134 p. / Funds of Sc.Technical Library of YugNIRO. (Unpublished)

Shulman, G. & Kulikova, N. 1966. On the specificity of fish serum protein composition. Usp. Sovr. Biol. 62, 42-60. (in Russian).

Simonov AI, Ryabinin AI, Gershanovitch DE (eds 1992). Project "The USSR seas". Hydrometheorology and hydrochemistry of the USSR seas. Vol. 4: Black Sea, no. 1: Hydrometheorological conditions and oceanological bases of the biological productivity. Hydrometheoizdat, Sankt Peterbourg. (In Russian).

Sivkov, Ya. 2004. Morphological properties of Horse mackerel, *Trachurus mediterraneus ponticus* Aleev (Osteichthyes: Carangidae) from the Bulgarian Black Sea coast. Bulletin du Musee National de Varna, 36–37 (51–52): 259–265. (In Bulgarian).

Smith BS (1971) Sexuality in the American mud snail, Nassarius obsoletus Say. Proc Malacol Soc Lond 39:377–378

Sparre P., S. C. Venema, 1998. Introduction to tropical fish stock assessment. Part I: Manual. FAO Fisheries Technical Paper, 306/1, rev.2, DANIDA, Rome FAO. 407p. ISBN 92-5-103996-8.

STECF (2011) Scientific, Technical and Economic Committee for Fisheries. Assessment of Black Sea Stocks (STECF-11-16). Edited by Georgi Daskalov and Hans-Joachim Ratz. 7-11 November 2011 Belgium-Brussels.

Stoyanov, St., Georgiev, Z., Ivanov, L., Nikolov, P., Kolarov, P., Aleksandrova, K. & Karapetkova, M. 1963. Fishes in Black Sea. State Publishing house, Varna, 101 pp.

Svetovidov, A.N. 1964. The fishes of the Black Sea. Opred Faune SSSR, 86 pp. (In Russian).

Tihonov, V., Vinnov, S., Paraketsov, I., Tkacheva, K. 1955. Material knowledge of the large size type of Black Sea Horse Mackerel image life. Tr. Az. Cherniro. Vol. 16: 177-191. (In Russian).

Tkacheva, K. 1957. Reproduction of the giant scad (*Trachurus trachurus* L.) in the Black Sea. Vopr. Ikhtiol. 8: 51-54. (In Russian).

TUIK (2014) Turkish Statistical Institute. Ankara.

Turan, C. 2004. Stock identification of Mediterranean horse mackerel (*Trachurus mediterraneus*) using morphometric and meristic characters. ICES J. Mar. Sci. 61, 774–781.

Türgan, G. 1958. The age determination of bonitos and pelamids. Balık ve Balıkçılık 6(3): 18–20

Uyan O, Aral O (2003) The larval development stages of the Japanese snail, *Rapana thomasiana,* Gross 1861, in the egg capsule. Turkish Journal of Zoology, 27:331-337.

Valkanov, Al., Marinov, H., Danov, H. & Vladev, P. 1978. Black Sea(collection) State Georgi Bakalov publ., Varna, 13 pp. (In Bulgarian).

Vinogradov, M. E., Shushkina E. A., Nikolaeva G. G. – 1993 State of zoocenoses in the open areas of the Black Sea in late summer 1992 // Oceanology. 33, No 3: 382-387 (in Russian.)

Yankova, M., Raykov, V. 2006a. Morphological properties of Horse mackerel, *Trachurus mediterraneus ponticus* Aleev (Osteichthyes: Carangidae) from the Black Sea. Turkish Journal of fisheries and Aquatic Sciences Vol.6, № 2, 85-91.

Yankova, M., Raykov, V. 2006b. Approximate assessment of the natural mortality rate of the horse mackerel, *Trachurus mediterraneus ponticus* Aleev in the Bulgarian Black Sea territorial waters. *Cercetary marine* INCD.M. №36, 341-348.

Yankova, M., Raykov, V. P., Bogomilova 2008. Diet composition of Horse mackerel, *Trachurus mediterraneus ponticus* Aleev, 1956 (Osteichthyes: Garangidae) in the Bulgarian Black Sea waters during the 2007-fishing season.Turkish Journal of Fisheries and Aquatic Sciences Volume 8, Number 2, 321-329.

Yankova, M., Raykov, V. 2009. Resent investigation on population structure of Horse mackerel (*Trachurus mediterraneus ponticus* Aleev., 1956) in the Bulgarian Black Sea coast. Proceedings of the Institute of Fishing Resources Varna, Volume 27, 39-46.

Yankova, M. 2009. Condition factor, sex ratio and length-weight relationship, of Horse mackerel (*Trachurus mediterraneus*) from the Bulgarian Black Sea coast. Proceedings of the Union of Scientists – Varna, Series "Technical Sciences" 2'2008/1'2009, 70-72.

Yankova, M. 2010. Some biological aspects of the horse mackerel catch of the Bulgarian Black Sea Coast. Cercetari marine - Recherches marines, 39, NIMRD, 239-249.

Yankova, M., Raykov, V., Gerdzhikov, D., Bogomilova, P. 2010a. Growth and Length-Weight Relationships of the Horse Mackerel, *Trachurus mediterraneus ponticus* (Aleev, 1956) in the Bulgarian Black Sea Coast. Turkish Journal of Zoology, Volume 34, Issue 1, 85-92.

Yankova, M. Mihneva, V. Radu, G. Mehanna, S. 2010. General Biology of horse mackerel *Trachurus mediterraneus* (Aleev, 1956) off the Bulgarian Black Sea Coast. Proceedings of the Union of Scientists – Varna Series "Marine Science" 2'2010, 73-77.

Yankova, M. Pavlov, D. Raykov, V. Michneva, V. Radu, Gh. 2011. Length-Weight Relationships of Ten Fish Species from the Bulgarian Black Sea waters. *Turkish Journal of Zoology*, 35(2): 265-270.

Yankova, M. 2011. General reproductive biology of horse mackerel *Trachurus mediterraneus* in the Bulgarian Black Sea Coast. Animal Diversity Natural History and Conservation (Edited by V.K.Gupta), Vol.1., 241-247.

Yankova, M. 2011. An overview on the distribution of horse mackerel *Trachurus mediterraneus* in the Black Sea. Proceedings of the Union of Scientists – Varna, Series "Marine Science", 89-91pp., ISSN 1314-3379.

Yankova, M., Raykov, V. 2012. Growth, Mortality and Yield per Recruit of Horse Mackerel (*Trachurus mediterraneus*) from the Bulgarian Black Sea Waters. *Journal of Environmental Protection and Ecology,* vol.13, no. 3A, 1817-1824 pp., ISSN 1311-5065.

Yankova, M., 2013a. Population Dynamics of Horse Mackerel (*Trachurus mediterraneus ponticus*) in the Bulgarian Black Sea Coast. ISRN Zoology, ID 127287 2013, doi:1155/2013/127287.

Yankova, M., 2013b. An overview on the biology of horse mackerel, *Trachurus mediterraneus*, off the Bulgarian Black Sea coast. Animal Diversity, Natural History and Conservation, Daya Publishing House, New Delhi, (Edited by V. K.Gupta and Anil K. Verma), Vol.2., ISBN: 978-81-7035-831-2, 165-179.

Yankova, M., 2013c. A study on the growth of horse mackerel (*Trachurus mediterraneus* Aleev, 1956) from Bulgarian waters of the Black Sea using length frequency analysis. *J. Black Sea/Mediterranean Environment* Vol. 19, No. 1: 111-120.

Yankova, M., Stefanova K., Doncheva V. 2013. Influence of the marine environment variability on the population parameters of horse mackerel (*Thrachurus mediterraneus ponticus* Aleev, 1956) in the Bulgarian Black Sea coast. In Proceedings of the Union of Scientists Varna, Series "Marine Science" ISSN 1314-3379, 31-38.

Yankova, M., Pavlov D., Ivanova P., Karpova E., Boltachev A., Öztürk B., Bat L., Oral M., Mgeladze M. 2014. Marine fishes in the Black Sea: recent conservation status *Mediterranean Marine Science*. 15/2, 366-379DOI: http://dx.doi.org/

10.12681/mms.700, 366-379.
Yankova, M., 2014a. External Morphological Study of Horse mackerel (*Trachurus mediterraneus ponticus* Aleev, 1956) with Reference to Body Weight, Total Length and Condition Factor from the Bulgarian Black Sea coast. Animal Diversity, Natural History and Conservation, Daya Publishing House, New Delhi, (Edited by V. K.Gupta and Anil K. Verma), (in press).
Yankova, M., 2014b. Length-weight relationship of horse mackerel *Trachurus mediterraneus* Aleev, 1956 from Bulgarian Black Sea coast. Black Sea/Mediterranean Environment, Vol. 20, No. 1, 18 - 24.
Yoshida HO (1980). Synopsis of biological data on bonitos of the genus Sarda. NOAA Tech. Rep. NMFS Circ. 432. FAO Fish Synop 118: 1–50
Zaboukas N, Miliou H, Megalofonou P, Moraitou-Aposolopoulou M (2006). Biochemical composition of the Atlantic bonito Sarda sarda from the Aegean Sea (eastern Mediterranean Sea) in different stages of sexual maturity. J Fish Biol 69: 347–362
Zengin, M., Düzgüneş, E., Genç, Y., 1998, Evaluation of Data From Market Samples on the Commercial Fish Species in the Black Sea During 1990-1995, The Proceeding of the First International Symposium on Fisheries and Ecology, 2-4 Sept. 1998, Trabzon, Turkey (Editors; Çelikkale, M.S., Düzgüneş, E., Okumuş, İ., Mutlu, C.), 91-99 pp.
Zengin, M., 2001., Doğu Karadeniz'deki Balıkçılık Kaynaklarının Son Durumu ve Balık Stoklarının Yönetimine İlişkin Öneriler, IV. Ulusal Ekoloji ve Çevre Kongresi, 5-8 Ekim 2001, (Ed., Gündüz. C., Buhan, E., Şenol, T.) Bodrum, 249-264.
Zengin, M., Düzgüneş, D., Dincer, C., Mutlu, C., Bahar, B., 2002, Karadeniz'de Orta Su Trolünün Kullanım Olanakları ve Av Verimliliğinin Araştırılması, Tarım Köyişleri Bakanlığı, TAGEM, Trabzon Su Ürünleri Merkez Araştırma Enstitüsü, Sonuç Raporu, Project No: TAGEM/IY/98/17/03/007, 126.
Zengin, M. 2003. The Current Status of Turkey's Black Sea Fisheries and Suggestions on the Use of Those Fisheries, Workshop on Responsible Fisheries in the Black Sea and the Azov Sea, and Case of Demersal Fish Resources, April 15-17 2003, Şile, İstanbul, BSEP Programme, Country Report, 34p.
Zengin M (2006) Effects of the Trawl and Snail Fisheries on the Resources of Benthic Macro Fauna in the Middle Black Sea Coast, Samsun, Turkey-1st Biannual Scientific Conference. Black Sea Ecosystem 2005 and Beyond. BSERP/BSC 8-10 May 2006 Istanbul, Turkey.
Zengun, Gumus, 2014. Turbot Fisheries: 2014 STECF- Black Sea Subgroup Report.
Zhivkov, M., Prodanov, K., Trichkova, T., Rajkova-Petrova, G. & Ivanova, P. 2005. The Fishes in Bulgaria – investigations, protection and stable using. In: Petrova, A., Contemporary state of biodiversity in Bulgaria – problems and perspectives. Drakon, Sofia, 247-281. (In Bulgarian).
Zolotarev V (1996) The Black Sea ecosystem changes related to introduction of new mollusc species. Marine Ecology 17:227-236.
Zusser, S.G. 1954. Biology and fishery for bonito in the Black Sea. Tr. VNIRO 28: 160–174.

9. CONTACT DETAILS OF STECF MEMBERS AND EWG-14-14 LIST OF PARTICIPANTS

Information on STECF members and invited experts' affiliations is displayed for information only. In some instances the details given below for STECF members may differ from that provided in Commission COMMISSION DECISION of 27 October 2010 on the appointment of members of the STECF (2010/C 292/04) as some members' employment details may have changed or have been subject to organisational changes in their main place of employment. In any case, as outlined in Article 13 of the Commission Decision (2005/629/EU and 2010/74/EU) on STECF, Members of the STECF, invited experts, and JRC experts shall act independently of Member States or stakeholders. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and invited experts make declarations of commitment (yearly for STECF members) to act independently in the public interest of the European Union. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

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10. List of Background Documents

Background documents are published on the meeting's web site on:
http://stecf.jrc.ec.europa.eu/web/stecf/ewg1414

List of background documents:

1. EWG-14-14 – Doc 1 - Declarations of invited and JRC experts (see also section 9 of this report – List of participants)

European Commission

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Abstract
The Expert Working Group meeting of the Scientific, Technical and Economic Committee for Fisheries EWG 14-14 was held from 6 -10 October 2014 in Barza d'Ispra, Italy to assess the status of demersal and small pelagic stocks in the Mediterranean Sea against the proposed F_{MSY} reference points.
The report was reviewed by the STECF by written procedure in October 2014.

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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